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APPENDICES TO

AN ENGINEERING STUDY

FOR THE

REMOVAL AND DISPOSITION OF PCB CONTAMINATION

IN THE

WAUKEGAN HARBOR AND NORTH DITCH

AT

WAUKEGAN, ILLINOIS

FINAL REPORT

Submitted to:

United States Environmental Protection Agency
Region V
Chicago, Illinois
Contract No. 68-03-2647

Prepared By:

Mason & Hanger-Silas Mason Co., Inc.
Lexington Engineering Office
1500 West Main
Lexington, Kentucky 40505

January 1981

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APPENDIX 1

WAUKEGAN HARBOR CONTAMINATION DATA FROM VARIOUS SOURCES

Sampling performed by: Soil Testing Service, 111 Pfingsten Road, Northbrook, Illinois 60062

Date Obtained: September 1976

Analysis performed by: Dearborn Chemical of Lake Zurich, Illinois

Date Performed: November 1976

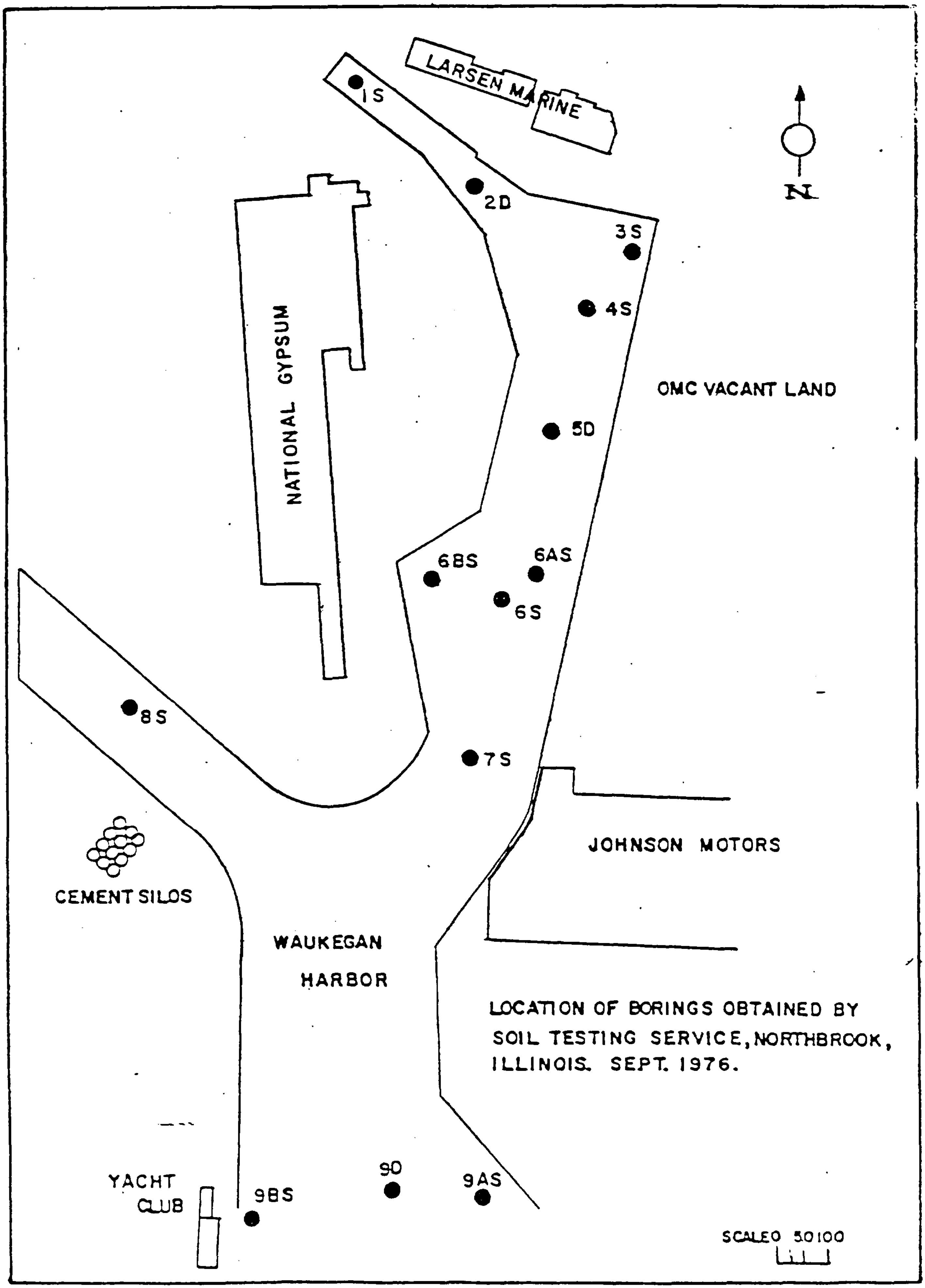
Information obtained from: Draft of Report - Subsurface Sampling and Chemical Analysis of Soil Samples Obtained at Outboard Marine's Waukegan, Illinois Facility, Dated January 18, 1977.

Lake elevation: 580.9 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
1S	S-1	574.4	564.9	0.1	Sand	N/A	N/A
1S	S-2	574.4	560.4	1.1	Clay	N/A	N/A
2D	S-1	569.4	563.9	0.1*	Sand	N/A	N/A
2D	S-2	569.4	559.9	0.1*	Clay	N/A	N/A
3S	S-1	564.4	557.9	0.4	Sand	N/A	N/A
3S	S-2	564.4	554.9	0.1*	Clay	N/A	N/A
4S	S-1	561.4	554.4	0.1*	Clay	N/A	N/A
5D	S-1	561.4	552.9	0.1*	Clay	N/A	N/A
6AS	S-1	557.4	555.4	0.3	Sand	N/A	N/A
6AS	S-2	557.4	553.4	0.1*	Clay	N/A	N/A
6S	S-1	561.4	553.9	1.9	Clay	N/A	N/A
6S	S-2	561.4	554.4	0.3	Composite	N/A	N/A
6S	S-3	561.4	556.4	2.2	Sand	N/A	N/A
6BS	S-2	562.4	557.9	0.1*	Sand	N/A	N/A
6BS	S-1	562.4	555.4	0.1*	Clay	N/A	N/A
7S	S-1	557.4	554.9	0.1*	Clay	N/A	N/A
8S	S-1	557.4	551.9	0.1*	Clay	N/A	N/A
9AS	S-1	553.9	551.4	0.1*	Clay	N/A	N/A
9BS	S-1	562.4	554.4	0.1*	Clay	N/A	N/A
9D	S-1	556.9	554.4	0.1*	Sand	N/A	N/A
9D	S-2	556.9	550.9	0.1*	Clay	N/A	N/A

* Less Than 0.1 PPM

N/A = Data Not Available


LARSEN MARINE
1S
2D
3S
4S
N
NATIONAL GYPSUM
OMC VACANT LAND
5D
6BS
6AS
6S
8S
7S
JOHNSON MOTORS
CEMENT SILOS
WAUKEGAN
HARBOR
LOCATION OF BORINGS OBTAINED BY
SOIL TESTING SERVICE, NORTHBROOK,
ILLINOIS. SEPT. 1976.
YACHT
CLUB
9BS
9D
9AS
SCALE 0 50 100

WAUKEGAN HARBOR CONTAMINATION DATA

Sampling performed by: Civil and Environmental Engineering Department and Water Chemistry Program University of Wisconsin, Madison, Wisconsin,

Date Obtained: July 17, 1978

Analysis performed by: Water Chemistry Laboratory 660 North Park Street, Madison, Wisconsin 53706

Date Performed:

Information obtained from: Final Report on Sediment Sampling, Water Sampling, and PCB Analysis in Lake Michigan to JRB Associates, Inc., July 1980.

Lake elevation: 580.3 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
W-1	N/A	575.4	575.4	146/215/361*	N/A	14.3	N/A
W-2	N/A	572.4	572.4	1876/1758/3634	N/A	20.6	N/A
W-3	N/A	570.8	570.8	755/18/773	N/A	49.5	N/A
W-4	N/A	572.4	572.4	386/79/464	N/A	31.0	N/A
W-5	N/A	566.2	566.2	162/19/182	N/A	57.0	N/A
W-6	N/A	564.2	564.2	110/18/128	N/A	64.9	N/A
W-7	N/A	564.2	564.2	28/15/43	N/A	59.6	N/A
W-8	N/A	564.2	564.2	20/15/35	N/A	53.1	N/A
W-9	N/A	560.3	560.3	3/5/8	N/A	57.2	N/A
W-10	N/A	565.2	565.2	3/9/12	N/A	64.2	N/A
W-13	N/A	558.3	558.3	7/20/27	N/A	34.2	N/A
W-14	N/A	560.3	560.3	5/5/10	N/A	41.1	N/A
W-15	N/A	558.3	558.3	7/13/20	N/A	50.4	N/A
W-16	N/A	564.3	564.3	2/7/10	N/A	67.0	N/A
W-17	N/A	560.3	560.3	3/8/11	N/A	60.9	N/A
W-18	N/A	562.3	562.3	4/8/12	N/A	41.8	N/A

* Aroclor 1242/Aroclor 1248/Total
NA = Not Available

WAUKEGAN HARBOR CONTAMINATION DATA

Sampling performed by: Central Region Federal EPA, Chicago, Illinois and Illinois EPA, Springfield, Illinois

Date Obtained: Feb. 1977

Analysis performed by: Illinois Natural History Survey Pesticide Laboratory, Urbana, Illinois

Date Performed: March 1977
Information obtained from: Memorandum from Ron Barganz, Field Operations Section, DWPC, to Benn J. Leland, Maywood Office, FOS/DWPC, Illinois EPA, May 16, 1977
Lake elevation: 579.35 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
1	16001	571.35	570.35	141,922/43,669*	Sand*	57.4**	4'-5"
1	16002		569.35	19,171/5,574	Sand*	32.0**	Total
1	16003		568.35	34.81/13.85	Sand	18.2	
2C	16008	571.35	570.35	33.24/3.56	Sand/Muck	15.7	4'-5"
2C	16009		569.35	0.36/0.12	Sand	16.2	Total
2C	16010		568.35	0.06/0.02	Sand/Gr.	12.2	
2C	16011		567.35	0.29/0.91	Sand/Gr	13.2	
3	16012	570.35	569.35	0.21/0.09	Sand/Muck	25.2	3'-0"
3	16013		568.35	0.40/0.20	Sand	16.2	Total
3	16014		567.35	0.42/0.18	Sand/Gr.	14.7	
5	16020	561.35	560.85	168.52/25.96	Muck	48.2	4'-6"
5	16021		559.35	776.64/152.62	Muck	59.7	Total
5	16022		558.85	2.46/1.40	Muck	58.2	
5	16023		557.85	0.19/0.08	Sand/Muck	46.4	
5	16024		556.85	0.12/0.05	Sand/Muck	51.0	
5	16025		555.85	0.29/0.04	Sand/Muck	51.2	
7	16033	562.35	561.35	102.81/19.36	Muck	54.2	3'-10"
7	16034		560.35	374.78/59.35	Muck	55.2	Total
7	16035		559.35	557.75/55.15	Muck	60.2	
7	16036		558.35	3.56/0.66	Sand	37.2	
9	16040	556.35	556.35	28.43/5.31	Muck	45.2	1'-0"
9	16041		555.35	0.04/0.03	Muck	11.4	Total
11	16047	568.35	567.35	0.11/0.07	Sand	17.0	9'-6"
11	16048		566.35	0.11/0.05	Sand	17.0	Total
11	16049		565.35	0.29/0.08	Sand	16.0	
11	16050		564.35	0.12/0.09	Sand	17.2	
11	16051		563.35	0.11/0.08	Sand	18.2	
11	16052		562.35	0.22/0.06	Sand	17.4	
11	16053		561.35	0.07/0.04	Sand	16.2	
11	16054		560.35	0.17/0.10	Sand	18.2	
11	16055		559.35	1.22/0.37	Sand	19.7	
11	16056		558.35	0.09/0.05	Sand	23.7	
12B	16062	557.35	556.35	5.95/3.03	Sand/Muck	40.2	2'-8"
12B	16063		555.35	4.29/1.90	Sand/Muck	36.4	Total
12B	16064		554.35	18.23/7.12	Sand/Muck	39.0	
13	16065	560.35	559.35	8.91/4.01	Sand/Muck	47.0	5'-6"
13	16066		558.35	11.54/4.03	Sand/Muck	26.0	Total
13	16067		557.35	3.23/1.03	Sand/Muck	28.4	
13	16068		556.35	5.19/3.83	Muck	50.0	
13	16069		555.35	22.78/9.17	Muck	44.4	
13	16070		554.35	15.21/5.62	Muck	43.2	

* Aroclor 1016/Aroclor 1254

** Identified as sand by sampling agency, however moisture content indicates muck.

WAUKEGAN HARBOR CONTAMINATION DATA

Sampling performed by: Environmental Control Technology Corporation (ENCOTEC)
3893 Research Park Dr., Ann Arbor, Michigan 48104

Date Obtained: April 1977

Analysis performed by: Environmental Control Technology Corporation (ENCOTEC)

Date Performed: April 1977

Information obtained from: Mr. John E. Schenk's (ENCOTEC) Letter with attached Report
To Mr. Richard Kissel, December 1977 (N. C. C. S: Sediment Survey April 1977)

Lake elevation: 579.8 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER DEPTH	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
B-1	N/A	N/A	560	0.65	Sand	N/A	1 Ft.
B-1	N/A	N/A	561	0.10	Sand	N/A	1 Ft.
B-1	N/A	N/A	562	0.055	Sand	N/A	1 Ft.
B-1	N/A	N/A	563	0.50	Sand	N/A	1 Ft.
B-1	N/A	N/A	564	0.56	Sand	N/A	1 Ft.
B-1	N/A	N/A	565	54	Muck	N/A	1 Ft.
B-1	N/A	N/A	566	23	Muck	N/A	1 Ft.
B-1	N/A	N/A	567	520	Muck	N/A	1 Ft.
B-1	N/A	N/A	568	8400	Muck	32.3	1 Ft.
B-2	N/A	N/A	560	0.99	Sand	N/A	1 Ft.
B-2	N/A	N/A	561	0.32	Sand	N/A	1 Ft.
B-2	N/A	N/A	562	1.5	Sand	N/A	1 Ft.
B-2	N/A	N/A	563	0.31	Sand	N/A	1 Ft.
B-2	N/A	N/A	564	0.35	Sand	N/A	1 Ft.
B-2	N/A	N/A	565	0.20	Sand	N/A	1 Ft.
B-2	N/A	N/A	566	0.54	Sand	N/A	1 Ft.
B-2	N/A	N/A	567	4.1	Muck	N/A	1 Ft.
B-2	N/A	N/A	568	97	Muck	20.0	1 Ft.
B-3	N/A	N/A	559	0.39	Sand	N/A	1 Ft.
B-3	N/A	N/A	561	4.6	Sand	N/A	1 Ft.
B-3	N/A	N/A	561.75	3.0	Sand	N/A	0.75 Ft.
B-3	N/A	N/A	562.25	310	Muck	N/A	1 Ft.
B-3	N/A	N/A	563.25	65	Muck	41.3	1 Ft.
B-4	N/A	N/A	557	310	Muck	N/A	1 Ft.
B-4	N/A	N/A	558.75	3.5	Muck	N/A	1.75 Ft.
B-4	N/A	N/A	559	130	Muck	68.1	0.75 Ft.
B-5	N/A	N/A	556	1.1	Sand	N/A	0.5 Ft.
B-5	N/A	N/A	556.5	0.59	Sand	N/A	1 Ft.
B-5	N/A	N/A	557.5	69	Muck	N/A	1 Ft.
B-5	N/A	N/A	558.5	140	Muck	N/A	1 Ft.
B-5	N/A	N/A	559.5	140	Muck	56.3	1 Ft.
B-6	N/A	N/A	556	58	Muck	N/A	0.3 Ft.
B-6	N/A	N/A	556.6	63	Muck	41.3	0.3 Ft.
B-7	N/A	N/A	555	0.32	Clay	16.3	1 Ft.
B-8	N/A	N/A	555	0.062	Sand/Clay	N/A	1 Ft.
B-8	N/A	N/A	555.3	0.054	Sand	N/A	0.3 Ft.
B-8	N/A	N/A	555.6	0.066	Sand	N/A	0.3 Ft.
B-8	N/A	N/A	556.6	5.4	Muck	N/A	1 Ft.
B-8	N/A	N/A	557.2	35	Muck	N/A	0.5 Ft.
B-8	N/A	N/A	558	51	Muck	N/A	1 Ft.
B-8	N/A	N/A	559	1.6	Muck	N/A	1 Ft.
B-9	N/A	N/A	555	0.25	Clay	N/A	1 Ft.
B-9	N/A	N/A	556	0.28	Muck	N/A	1 Ft.
B-9	N/A	N/A	556.5	1.4	Muck	28.1	0.5 Ft.
B-10	N/A	N/A	556	0.083	Clay	N/A	1 Ft.
B-10	N/A	N/A	556.5	0.089	N/A	N/A	0.5 Ft.
B-10	N/A	N/A	557	0.14	N/A	N/A	0.5 Ft.
B-10	N/A	N/A	558	0.078	N/A	N/A	1 Ft.
B-10	N/A	N/A	559	0.13	N/A	N/A	1 Ft.
B-10	N/A	N/A	560	1.9	N/A	N/A	1 Ft.
B-10	N/A	N/A	561	0.57	N/A	N/A	1 Ft.
B-10	N/A	N/A	562	9.7	N/A	24.8	1 Ft.

N/A = Not Available

WAUKEGAN HARBOR CONTAMINATION DATA

Sampling performed by: Environmental Control Technology Corporation (ENCOTEC)
3893 Research Park Dr., Ann Arbor, Michigan 48104

Date Obtained: April 1977
Analysis performed by: Environmental Control Technology Corporation (ENCOTEC)

Date performed: April 1977
Information obtained from: Mr. John E. Schenk's (ENCOTEC) Letter with attached Report to Mr. Richard Kissel, December 1977 (M, C, C, S: Sediment Survey April 1977)

Lake elevation: 579.8 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER DEPTH	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
H-11	N/A	N/A	556	1.1	N/A	18.3	1 Ft.
H-12	N/A	N/A	555.5	0.028	N/A	10.4	1 Ft.
H-13	N/A	N/A	555.5	11	N/A	N/A	1 Ft.
H-13	N/A	N/A	556.5	23	N/A	N/A	1 Ft.
H-13	N/A	N/A	557.5	6.7	N/A	N/A	1 Ft.
H-13	N/A	N/A	558.5	2.8	N/A	39.7	1 Ft.
H-14	N/A	N/A	555.5	5.1	N/A	N/A	1 Ft.
H-14	N/A	N/A	556.5	1.6	N/A	N/A	1 Ft.
H-14	N/A	N/A	557.5	0.052	N/A	N/A	1 Ft.
H-14	N/A	N/A	558.5	0.014	N/A	18.9	1 Ft.
H-15	N/A	N/A	555.5	1.1	N/A	N/A	1 Ft.
H-15	N/A	N/A	556.5	3.3	N/A	N/A	1 Ft.
H-15	N/A	N/A	557.0	0.062	N/A	23.2	0.5 Ft.

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois
Date Obtained: June 1979

Analysis performed by: Environmental Research Group
Date Performed: July 1979

Information obtained from: Report-Sampling and Analysis of Water and Sediment Samples Taken from Waukegan Harbor Before, During and After Maintenance Dredging, performed for USEPA Region V on behalf of JRB Associates, Inc., McLean, Virginia, June, 1979

Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S01	S01-1	579.6	574.4	840	Muck		6"
S01	S01-2		574.35	5,000			Total
S01	S01-3		574.27	780			
S01	S01-4		574.18	94			
S01	S01-5		574.10	110			
S01	S01-6		573.77	89			
S02	S02-1		569.1	1,800	Muck		1'-10"
S02	S02-2		568.93	24,800			Total
S02	S02-3		568.77	79,000			
S02	S02-4		568.60	70,400			
S02	S02-5		568.43	55,000			
S02	S02-6		568.27	97,000			
S02	S02-7		568.1	165,000			
S02	S02-8		567.93	470,000			
S02	S02-9		567.77	537,000			
S02	S02-10		567.6	570,000			
S02	S02-11		566.89	140,000	–		
S03	S03-1		572.53	2,500	Muck		3'-0"
S03	S03-2		572.36	25			Total
S03	S03-3		572.19	20			
S03	S03-4		572.02	1,000			
S03	S03-5		571.85	110			
S03	S03-6		571.68	64			
S03	S03-7		571.51	100			
S03	S03-8		571.34	90			
S03	S03-9		571.17	34,000			
S03	S03-10		571.00	46			
S03	S03-11		570.83	72			
S03	S03-12		570.66	19,000			
S03	S03-13		570.49	59,000			–
S03	S03-14		570.32	46,000			
S03	S03-15		570.15	17,000			
S03	S03-16		569.98	440,000			
S03	S03-17		569.81	630			
S03	S03-18		569.64	370			
S07	S07-1		569.64	160	Muck		1'-3"
S07	S07-2		569.48	1,200			Total
S07	S07-3		569.32	620			
S07	S07-4		569.16	1,300			
S07	S07-5		569.00	14,000			
S07	S07-6		568.84	11,000			
S07	S07-7		568.68	3,300			
S07	S07-8		568.52	21			
S08	S08-1		569.8	250	Muck		
S08	S08-2		569.8	1,600			
S08	S08-3		569.8	4,400			
D03	D03-1	579.6	572.53	5,200	Muck		3'-0"
D03	D03-2		572.36	3,100			Total
D03	D03-3		572.19	27,000			
D03	D03-4		572.02	21,000			
D03	D03-5		571.85	19,000			
D03	D03-6		571.68	8,400			
D03	D03-7		571.51	14,000			
D03	D03-8		571.34	120,000			
D03	D03-9		571.17	21,000			
D03	D03-10		571.00	330,000			
D03	D03-11		570.83	200,000			
D03	D03-12		570.66	28,000			
D03	D03-13		570.49	52,000			
D03	D03-14		570.32	74,000			
D03	D03-15		570.15	420,000			
D03	D03-16		569.98	9,100			
D03	D03-17		569.81	330			
D03	D03-18		569.64	310			

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

Date Obtained: June 1979

Analysis performed by: Environmental Research Group

Date Performed: July 1979

Information obtained from: Report-Sampling and Analysis of Water and Sediment Samples Taken from Waukegan Harbor Before, During and After Maintenance Dredging, performed for USEPA Region V on behalf of JRB Associates, Inc., McLean, Virginia, June, 1979

Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S05	S05-1		568.1	970	Muck		3'-0"
S05	S05-2		567.93	2,900			Total
S05	S05-3		567.76	2,800			
S05	S05-4		567.59	3,500			
S04	S05-5		567.42	8,000			
S05	S05-6		567.25	30,000			
S05	S05-7		567.08	60,000			
S05	S05-8		566.91	80,000			
S05	S05-9		566.74	52,000			
S05	S05-10		566.57	120,000			
S05	S05-11		566.40	76,000			
S05	S05-12		566.23	15,000			
S06	S06-1		569.4	520	Muck		
S06	S06-2		569.3	8,000			
S06	S06-3		569.2	220			
S06	S06-4		569	2,500			
S10	S10-1		566.27	550	Muck		2'-4"
S10	S10-2		566.04	270			Total
S10	S10-3		565.81	240			
S10	S10-4		565.58	290			
S10	S10-5		565.35	300			
S10	S10-6		565.12	1,400			
S10	S10-7		564.89	330			
S10	S10-8		564.66	350			
S10	S10-9		564.43	700			
S10	S10-10		564.20	950			
S12	S12-1		561.50	80	Muck		1'-7"
S12	S12-2		561.32	180			Total
S12	S12-3		561.14	260			
S12	S12-4		560.96	480			
S12	S12-5		560.78	580			
S12	S12-6		560.60	250			
S12	S12-7		560.42	40			
S12	S12-8		560.24	4.9			
S12	S12-9		560.06	0.99 (Bottom)			
S11	S11-1		563.5	230	Muck		1'-7"
S11	S11-2		563.34	95			Total
S11	S11-3		563.18	18/15*			
S11	S11-4		563.02	110			
S11	S11-5		562.86	3			
S11	S11-6		562.70	30			
S11	S11-7		562.54	2.5			
S11	S11-8		562.38	2.7			
S11	S11-9		562.22	0.80			
S11	S11-10		562.06	0.40 (Bottom)			
S07	S07		568.55	59 (Bottom)	Muck		1'-3" Total
S09	S09-1		571.1	1.7	Muck		0'-6"
S09	S09-2		570.8	0.14			Total
S09	S09-3		570.6	0.31			
S13	S13-1		560.9	38	Muck		1'-6"
S13	S13-2		560.58	21			Total
S13	S13-3		560.26	8.0			
S13	S13-4		559.94	2.3/3.4*			
S13	S13-5		559.3	0.71 (Bottom)			
S14	S14-1		561.6	38	Muck		0'-10"
S14	S14-2		561.4	48			Total

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

Date Obtained: June 1979

Analysis performed by: Environmental Research Group

Date Performed: July 1979

Information obtained from: Report-Sampling and Analysis of Water and Sediment Samples Taken from Waukegan Harbor Before, During and After Maintenance Dredging, performed for USEPA Region V on behalf of JRB Associates, Inc., McLean, Virginia, June, 1979.

Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S15	S15-1		559.3	32	Muck		1'-11"
S15	S15-2		559.0	17			Total
S15	S15-3		558.71	20			
S15	S15-4		558.50	17			
S15	S15-5		558.20	64			
S15	S15-6		557.90	130			
S15	S15-7		557.4	150(Bottom)			
S16	S16-1		564.8	25	Muck		
S16	S16-2		564.5	34			
S16	S16-3		562.4	120			
S16	S16-4		563.9	230			
S16	S16-5		563.6	170			
S16	S16-6		563.3	77/150/170*			
S16	S16-7		563.0	31			
S16	S16-8		562.7	25			
S17	S17-1		558	11	Muck		1'-6"
S17	S17-2		557.8	58			Total
S17	S17-3		557.6	70/130*			
S17	S17-4		557.3	64			
S17	S17-5		557.1	7.7			
S17	S17-6		556.9	22/31/33*			
S17	S17-7		556.7	120			
S17	S17-8		556.5	23	Clay Plug		
D17	D17-1		558	24	Muck		1'-3"
D17	D17-2		557.8	25			Total
D17	D17-3		557.5	46			
D17	D17-4		557.3	38			
D17	D17-5		557.0	6.2			
D17	D17-6		556.8	42			
D17	D17-7		556.5	110			
D17	D17-8		556.3	27	Clay Plug		
S19	S19-1		559.9	26/30*	Muck		
S19	S19-2		559.7	13			
S19	S19-3		559.5	19/9.5*			
S19	S19-4		559.3	20/16*			
S19	S19-5		559.1	29/12*			
S19	S19-6		558.9	25			
S20	S20-1		556	5.4	Muck		
S20	S20-2		555.8	37/12.6*			
S20	S20-3		555.5	23			
S20	S20-4		555.2	13/13*			
S21	S21-1		556.6	26/12*	Muck		
S21	S21-2		556.4	23/17*			
S21	S21-3		556.2	47/43/48*			
S22	S22-4		556.20	78	Muck		1'-3"
S22	S22-5		556.05	61/48*			Total
S22	S22-6		555.9	22			
S22	S22-7		555.75	11			
S22	S22-8		555.6	3.4/8.8*			
S22	S22-9		555.45	52			
S22	S22-10		555.3	13/12/12*			
S22	S22-11		555.15	9.5			
S22	S22-12		555.0	18			
S22	S22-13		554.85	6.5			
S22	S22-14		554.7	12			
S22	S22-15		554.5	8			
S25	S25-20		564.20	1.6	Muck		1'-3" Total
S26	S26-Bottom		553.90	33 (Bottom)	Mcuk		1'-8" Total

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

Date Obtained: June 1979

Analysis performed by: Environmental Research Group

Date Performed: July 1979

Information obtained from: Report-Sampling and Analysis of Water and Sediment Samples taken from Waukegan Harbor Before, During and After Maintenance Dredging, performed for USEPA Region V on behalf of JRB Associates, Inc., McLean, Virginia, June, 1979.

Lake Elevation: 579.6

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S27	S27-1		555.0	11	Muck		1'-8"
S27	S27-7		554.6	13			Total
S27	S27-10		554.2	25			
S27	S27-11		553.8	9.6			
S27	S27-15		553.4	6.4			
D27	D27-1		555.0	14/56*	Muck		1'-8"
D27	D27-2		554.9	28/8.8*			Total
D27	D27-3		554.8	11			
D27	D27-4		554.7	14			
D27	D27-5		554.6	11.0/6.9*			
D27	D27-6		554.5	5.8/6.8*			
D27	D27-7		554.4	8.1/13*			
D27	D27-8		554.3	6.7			
D27	D27-9		554.2	53			
D27	D27-10		554.1	12			
D27	D27-11		553.0	4.1			
D27	D27-13		553.1	16			
D27	D27-14		553.2	9.5/6.8*			
D27	D27-16		553.3	13			
D27	D27-17		553.3	27			
D27	D27-Bottom		553.3	41			

* Duplicates

SOIL GEOTECHNICAL INFORMATION FROM WARZYN
FOR SAND UNDERLYING MUCK IN SLIP NO. 3

	CORE BORING AND DEPTH									
Screen Size*	B1-563.7'	B2-565'	B2-564.2'	B3-566.1'	B3-563.8'	B4-567.1'	B4-560.6'	B5-568.5'	B6-567.5'	B6-563.2'
1-1/2"	100	100	100	100	100	100	100	100	100	100
1"	100	100	100	100	100	100	100	100	100	100
3/4"	100	100	100	100	100	100	87.5	100	100	100
1/2"	82.1	100	100	100	100	100	87.5	100	100	100
3/8"	77.7	100	100	100	100	100	85.5	100	100	100
No. 4	71.5	99.5	99.4	100	99.8	100	77.0	98.7	99.4	100
No. 8	65.7	99.4	98.8	99.9	99.6	99.9	63.8	97.7	99.1	99.8
No. 10	63.5	99.3	98.6	99.9	99.6	99.9	60.7	97.6	98.9	99.7
No. 16	55.6	98.9	98.1	99.8	99.5	99.8	49.9	97.4	98.5	99.5
No. 30	46.6	98.7	97.2	98.9	99.3	99.5	37.1	97.3	98.1	99.3
No. 40	43.5	98.6	96.8	98.0	99.1	98.7	35.2	97.2	98.0	99.3
No. 50	35.2	98.0	96.2	88.7	98.9	87.6	33.6	96.8	97.3	99.0
No. 80	26.9	94.4	94.8	28.7	97.4	28.9	31.6	93.9	91.6	98.1
No. 100	16.2	85.3	91.0	12.6	91.7	13.7	30.0	84.6	74.2	97.0
No. 200	6.0	13.6	11.0	2.3	13.4	0.2	8.0	3.7	3.9	29.3
Unified Soil Classification	SP/SM	SM	SP/SM	SP	SM	SP	SP/SM	SP	SP	SM/SC
Density (lbs./cu..ft.)	N.A.	N.A.	N.A.	N.A.	N.A.	107.8	N.A.	106.4	N.A.	N.A.
Natural Moisture	10.2%	22.6	22.8	23.8	23.8	20.0	11.4	22.3	24.2	23.8

*Data is expressed as percent passing a specific screen size. Data will plot as a soil curve.

B1-563.7' means that a 6 inch segment taken from 563.7 to 564.2 foot elevation of boring B1 was homogenized. The weight percent material passing through the screen size is listed.

APPENDIX 2

PRELIMINARY DISCUSSION OF ENVIRONMENTAL CONSIDERATIONS RESULTING FROM FAILURE TO REMOVE PCB CONTAMINATION FROM NORTH DITCH AND WAUKEGAN HARBOR BY MASON & HANGER

PRELIMINARY DISCUSSION OF ENVIRONMENTAL CONSIDERATIONS RESULTING FROM FAILURE TO REMOVE PCB CONTAMINATION FROM NORTH DITCH AND WAUKEGAN HARBOR

by

Mason & Hanger (December 1980)

1.0 ENVIRONMENTAL HAZARDS OF PCB

Polychlorinated biphenyls (PCBs) discharged at Waukegan disperse into Lake Michigan and other Great Lakes. The PCBs accumulate in fish thus entering the food chain. Concentrations of up to 50 ppm of PCB have been found in Lake Michigan salmon and trout (1). A lesser amount of PCBs enter the human body through drinking water. For all practical purposes, PCBs are not biodegradable.

Dr. James Allen (2) at the University of Wisconsin has fed female rhesus monkeys diets containing 5 and 2.5 ppm of PCB for a period of six months before mating them with untreated males. Of the eight monkeys fed 5 ppm, five aborted; two did not conceive at all and one gave birth. Of the eight monkeys fed 2.5 ppm, five gave birth to very small infants and three aborted. The six baby monkeys were permitted to nurse from their mothers for a period of four months. During this period, three of the babies died.

In another test, conducted by Dr. Renate Kimbrough at the Center for Disease Control in Atlanta, rats fed 100 ppm of PCBs in their diet for 21 months developed a high incident of carcinomas (26 out of 184 rats) and neoplastic nodules (144 out of 184 rats) in their livers. Only one out of 173 control animals developed tumors.

Ranch minks in Wisconsin, fed coho salmon from Lake Michigan with 10 to 15 ppm PCBs, stopped reproducing or their offspring died (4).

Humans absorb PCBs through the lungs, skin, and gastrointestinal tract. After absorption, PCBs circulate through the blood and accumulate in fatty tissues and in organs. The Environmental Protection Agency estimates that 91 percent of Americans have measurable quantities of PCBs in their fatty tissues.

Studies (4) on humans exposed to PCBs (Yusho victims in Japan: workers at a New Jersey petrochemical facility) have shown significant increases in the rate of cancer of the liver, stomach, and pancreas compared with the normal population.

The biological magnification of PCBs that have entered the food chain seem to occur by a factor of 10 to 100 at each step (according to Griffin (5)). Fish and aquatic organisms accumulate PCBs by a factor of 10^4 over concentrations in the ambient waters. Predators at the top of the food chain can accumulate PCBs by a factor of 10^7 over concentrations found in ambient waters. Man, being at the top of most food chains, can amass substantial amounts of PCBs although only trace levels are present in waters of lakes.

2.0 WAUKEGAN HARBOR

2.1 Extent of Contamination

Mason & Hanger estimates more than 200,000 pounds of PCBs currently exist in Waukegan Harbor of which at least 95 percent are contained in Slip #3. The contamination is the result of Outboard Marine Corporation allowing PCBs to discharge from their outfall at the end of Slip #3 during the period 1959 thru the early 1970's. Much of the PCB is still near the plant outfall at concentrations in excess of 100,000 milligrams per kilogram of bottom sediment. Some of the PCB at the outfall at Slip #3 has sunk through approximately 10 feet of water, 4.5 feet of underlying muck, and finally through 4 feet of sand to pool on top of the relatively-impervious silty clay. There is some penetration into the clay. Most of the remaining PCB are adsorbed into the soft muck sediments, which are continuously being dispersed into the Harbor and out into Lake Michigan. A small amount of PCB continuously solubilizes into the water and disperses into Lake Michigan.

2.2 Mechanism of Dispersal of PCBs

2.2.1 Solubilization of PCBs into Water

Theoretically, the solubility of Aroclor 1242 in water is about 700 parts per billion. Higher chlorinated PCBs are less soluble; Aroclor 1248 is soluble to the extent of about 200 ppb, and Aroclor 1254 is soluble to the extent of 70 ppb. Fortunately the rate of solubilization of PCB into water is very slow.

In a laboratory test, Mason & Hanger mixed muck sediments containing 143 mg/kg of PCB with Waukegan Harbor water for a day. After removal of all suspended material (by coagulation, settling, and filtration), the water phase was found to contain 80 ppb of soluble PCB.

Water samples collected in Slip #3 (ENCOTEC, 1977) contain typically 2 to 10 ppb of PCB compared with 0.1 or 0.2 ppb of PCB in Lake Michigan near the Harbor. Some analyses show less than 5 ppb. Additional data taken in 1979 by Hydroscience (7) agreed with the ENCOTEC data, with the additional commentary that about 60 percent of the PCBs were soluble and the rest were associated with suspended solids. Storms can greatly increase the PCBs in the Harbor through dispersal of sediments.

Outboard Marine Corporation withdraws approximately one million gallons per day of water from Slip #3 for once-through cooling, sending about 150,000 gpd to North Ditch and the remainder back to Lake Michigan. If the one million gpd contained 5 ppb of PCB, about 15 pounds per year would be transferred back to Lake Michigan by this method.

Hydroscience, Inc. (7) using mathematical modeling has made a preliminary estimate of about 22 pounds of PCB per year which currently transfers from the Harbor into Lake Michigan. In the past, when OMC was discharging PCBs, it is believed much higher quantities of PCBs were discharged into the lake. The concentration of PCBs in Lake Michigan has gone down by a factor of four since OMC quit discharging PCBs. Mason & Hanger, upon examining the Hydroscience report, believes that the Hydroscience estimate of 22 pounds per year may be a bit low because the modeling does not account for sudden transfer during Seiches. Falcon Marine has reported water depth changes as much as four feet in a few hours when the wind changes directions.

2.2.2 Dispersal of Bottom Sediment

Hydroscience, Inc. (7) estimates that 40 percent of the total 22 pounds per year of PCBs transferred to Lake Michigan from the Harbor is in the form of dispersed sediment. This is a preliminary calculation subject to further revision. Mapping of the Harbor shows concentration of PCB in bottom sediments ranging from about 100,000 ppm near the OMC outfall to about 5 ppm near the mouth of the Harbor 5,000 feet away. Again, Mason & Hanger believe that the Hydroscience estimate may be low because failure to account for sudden changes in water level during Seiches may roil bottom sediments and cause rapid transfer of water out or into the harbor. Encotec believes that seiches do not have a major impact of sediment transfer to the Lake. However, Larson Marine reports considerable increase in turbidity in Slip #3 during Seiches and storms.

2.2.3 Dispersal of PCBs Into The Air

Generally, only PCBs dissolved in Waukegan Harbor water are in contact with air. The dissolved PCBs in Slip #3 water can measure roughly 5 ppb; Slip #3 covers an area of 75,000 square feet and averages 11 feet deep. The vapor pressure of AROCLOR 1242 is 10^{-4} mm Hg at 20°C and 10^{-5} mm Hg at 10°C.

Tofflemire (8) in the laboratory measured mass transfer coefficiencies of PCB (Aroclor 1242) from water into air under conditions of 2.0, 3.6 and 7.6 mph wind speed and with and without stirring of the water. If his mass transfer coefficient of $K = 0.004/hr$ (10 mph wind speed, 15°C water temperature) is used, the calculated PCB volatilization rate from Slip #3 should be roughly 9 lbs per year.

Hydroscience, Inc. (7) comments that there is a net transfer of PCBs into Lake Michigan from the atmosphere. This is probably currently the major source of PCBs into the Lake. A Duluth, Minnesota, EPA study has found rain water falling into Lake Michigan contained 0.2 ppb of PCBs on the average. Hydroscience, Inc. estimates that several thousand pounds per year reach Lake Michigan dissolved in rainwater.

2.2.4 Bioaccumulation of PCBs by Fish

Studies have shown that Waukegan Harbor fish accumulate PCBs at levels well above the current level of 5 ppm and the proposed level of 2 ppm established by the Food and Drug Administration. For example, fish samples taken within the Harbor (1) in 1978 showed PCB concentrations ranging from 3.5 ppm to 39 ppm (wet basis whole fish analyzed), with most fish showing between 15 and 35 ppm. The fish can move out of the Harbor to other locations in the Lake. Additional EPA studies showed that fish exposed to harbor water for 30 days have accumulated as much as 28 ppm PCBs); the fish lose PCBs when they return to the Lake, but still retain PCBs at a level of about 8 ppm after 114 days in the Lake.

The accumulation of PCBs in harbor fish is primarily due to fish feeding on organisms which live in the sediments or on smaller fish which feed on sediment. Hydroscience, Inc. (7) has estimated that if all sediments containing more than 10 ppm of PCBs are removed from the Harbor, the concentration of PCBs in harbor fish probably would not exceed 5 ppm.

3.0 NORTH DITCH AREA

3.1 Extent of Contamination

During the period from 1959 through the early 1970's, Outboard Marine Corporation allowed PCBs to discharge from their outfalls near their Die Storage Building into a surface drainage area known as North Ditch, which flows directly into Lake Michigan. Much of the PCBs has remained beneath the plant outfall, some of which has sunk through the sand and collected on top of the underlying hardpan clay 25 feet below the surface. Concentrations of PCB near the plant outfall exceed 100,000 ppm. In addition, PCBs have adsorbed onto surface sediments in the North Ditch, which continuously wash into Lake Michigan. The North Ditch area has apparently been dredged in the past, and the dredge spoils used as fill for the OMC parking lot. Soil borings show large areas of the parking lot to be contaminated at concentrations up to 10,000 ppm at a depth of up to 9 feet. Mason & Hanger estimates that approximately 160,000 cubic yards of soil are contaminated in excess of 50 mg/kg of which 30,000 cubic yards (19%) are near the outfall, another 105,000 cubic yards (66%) are in the parking lot, and 22,000 cubic yards (14%) are in North Ditch and adjacent shore downstream from the outfall. The total amount of PCB in the soils and sediments may roughly be one million pounds. Hydroscience, Inc. (7) estimates 253,000 pounds of PCB in the North Ditch sediments not counting contamination in the parking lot or the PCBs which have sank 25 feet below the surface to clay. This is a preliminary estimate. Mason & Hanger estimates over 261,000 pounds in the North Ditch sediments plus over 500,000 pounds elsewhere including PCBs which have sunk 25 feet below the surface.

3.2 Mechanisms of Dispersal of PCBs

3.2.1 Solubilization of PCBs Into Water

3.2.1.1 Surface Water

In a laboratory test, Mason & Hanger mixed contaminated North Ditch sediments containing 3600 mg/kg of PCB with water for a day, and then separated the water from the sediments (by coagulation, settling, and filtration). The PCB concentration remaining in the water was 130 ppb after suspended solids were removed.

Fortunately, the rate of solubilization of PCB into water is slow. Encotec (11) reports a dry weather base flow of 100,000 gpd and a concentration of 5 to 8 ppb of PCB measured in the water at the end of North Ditch. To this base figure must be added 150,000 gpd of cooling water discharge originating from Waukegan Harbor plus storm drainage. The dry weather flow of 100,000 gpd plus 150,000 gpd of cooling water is calculated to add 4 pounds per year of soluble PCB to Lake Michigan.

Average annual rainfall is 32 inches. Encotec, assuming 50 percent of the rain reaching the ditch as runoff, estimate an additional 6 pounds of soluble PCB reaches the Lake during storms.

3.2.1.2 Ground Water

Migration of PCB in ground water near North Ditch is under study by Douglas Cherkauer under EPA contract. His findings have not been released.

The problem is complex due to the burial of a substantial quantity of PCBs in the sand under the parking lot several hundred feet from Lake Michigan. Soil samples showed several ppm of PCBs to depths of 29 feet beneath the surface in the parking lot burial site. A soil sample taken at a depth of four feet on Lake Michigan shore between the burial site and the Lake contained 3.7 ppm PCB. No PCBs were detected in another beach core boring about a hundred feet south of first soil sample.

3.2.2 Movement of Sediments from North Ditch to Lake

A. W. Noehre and Graf (12) measured daily sediment loadings in North Ditch during the period March 25 through September 17, 1979. The daily discharge into Lake Michigan varied from 65,000 gpd to 1,160,000 gpd during this period. The sediment load varied from 15 to 450 pounds per day. The average daily sediment load was 25 pounds per day. An empirical equation was developed relating stream discharge (cubic feet per second) to sediment discharge (pounds per hour). A. W. Noehre estimated that the sediment discharge may be 220 lbs/hr during a 2-year flood peak and 1600 lbs/hr during the 100 year flood peaks. Unfortunately, the sediments collected were not analyzed for PCB content.

Other studies summarized by Battelle (13) show PCB concentrations in the bottom sediments range from 100 ppm towards the mouth of North Ditch to 246,000 ppm at the OMC outfall. Undoubtedly, suspended solids will carry varying amounts of PCB depending upon discharge rates. A concentration of 100 ppm of PCB in bottom sediments and a sediment discharge rate of 25 pounds per day would result in only 1 pound per year of PCBs discharged to the Lake. A more conservative estimate might be on the order of 5 or 10 pounds per year of PCB. Mason & Hanger believes that the average concentration of PCBs in the sediment discharged to the Lake is under 500 milligrams per kilogram of dry sediment; otherwise a concentration of PCBs higher than 100 ppm would be seen near the mouth of North Ditch.

3.2.4 Dispersal of PCBs Into The Air

PCB migration into the air can occur both from contaminated surface soils and from North Ditch water.

If North Ditch water is assumed to average 2 feet deep, an average temperature of 20°C, contain 5 ppb of PCB, and to have a surface area of 540,000 ft^2, then Mason & Hanger estimates about 15 pounds of PCB per year should be transferred to the air. This calculation assumes a K = 0.005 hr^{-1} calculated from Tofflemire's paper (8).

The dispersal from contaminated soils is more difficult to estimate. Concentration of PCBs in the air were on the order of 30 to 300 micrograms per cubic meter at the New York Caputo Dump Site before the Site was covered with manure and top soil. The sandy soils of the Caputo Dump Site contained 1,000 to 50,000 ppm PCB. This compares with measurements (9) of 0.007 micrograms per cubic meter in ambient air near Lake Michigan. Concentrations higher than 10 micrograms per cubic meter are sufficient to cause headaches and nausea of workers breathing the exposed fumes. PCB volatilization rate from freshly-exposed contaminated sand can be very high. The rate drops off as PCB evaporates from the top most portion of sand and PCBs from underlying subsurface layers diffuse to the top. Mason & Hanger believes that the volatilization rate may have been very high when PCBs were directly placed into the ground as when North Ditch dredge spoils were placed in the parking lot; the volatilization rate is probably insignificant today. PCB like odors can be detected if the topsoil is disturbed, and a sensitive nose can sometimes detect such odors walking about the plant outfall without disturbing soils (about 0.1 micrograms per cubic meter).

Laboratory tests (8) using Hudson River sand contaminated with an average of 64 ppm PCB yielded a value of 0.65 pounds PCB evaporation per month per acre (20°C, 10 mph wind).

The total Outboard Marine Corporation Land area where PCBs have been found is about 6 acres, of which 2 acres is now under asphalt and are not exposed to the air. Contamination at 9 inches (core boring B32) near the plant outfall measured 50,000 ppm PCB. Surface contamination away from the outfall is much less, but there are hot spots in the parking lot just beneath the surface measuring 10,000 ppb PCB. If the assumptions are made that (1) the Hudson River sand PCB evaporation rate can be used to estimate evaporation at OMC, (2) the evaporation rate is proportional to PCB concentration in the sand, and

(3) when the site was active (surfaces disturbed because of dredging) an average of 50,000 ppm of PCBs were exposed in a 0.6 acre area about the outfall plus another 1,000 ppm average PCB concentration exposed in the remaining 5.4 acres, then Mason & Hanger calculates a possible past volatilization rate on the order of 400 pounds of PCB per month.

Another calculation, assuming a past average air PCB concentration of 10 micrograms per cubic meter and 5000 cubic meters of air exchanged per second corresponds to a volatilization rate of about 300 pounds per month. These numbers are, of course, speculation, but the possibility exists that over 1,000 pounds per year of PCBs may have been evaporated to the air when the OMC was actively discharging PCBs.

Current PCB volatilization rates are believed much less. Taking a cue that PCB odors can sometimes be detected (0.01 micrograms per cubic meter) about the outfall, Mason & Hanger calculate about one pound per year currently dispersed to the air assuming an exchange of 1,500 cubic meters per second of air. Again these numbers are guesses, but Mason & Hanger believe that not much more than about a pound per year is currently dispersed to the atmosphere from the contaminated soils, or about 15 to 20 pounds per year total including volatilization from water surfaces.

3.2.5 Bioaccumulation of PCBs

Game fish are not known to exist in North Ditch; the mouth of North Ditch is partially blocked with sand and does not appear to allow an exchange of fish. Carp have been seen in North Ditch.

North Ditch, including the oval lagoon and crescent ditch areas near the outfall, is partially choked with algae during the summer. Cattails grow about the shore. Frogs live in the area. PCBs may enter food chain through birds feeding on insects, worms and frogs. This impact on the human food chain is expected to be minor because humans are not likely to consume wildlife which directly or indirectly feed at the North Ditch.

4.0 JUSTIFICATION OF DREDGING WAUKEGAN HARBOR

Removal of PCB contaminated sediments from Waukegan Harbor would prevent or significantly reduce bioaccumulation of PCBs in fish that reside in the harbor and may later move to Lake Michigan. This is the strongest justification for dredging Waukegan Harbor. All species of fish which spend time in the harbor accumulate PCBs.

Hydroscience, Inc. (7) has estimated that PCB accumulation levels in fish exposed to PCB contaminated sediments, and has estimated what PCB concentration would be in fish if Waukegan Harbor contaminated sediments were to be removed:

Waukegan Harbor PCB Removal Level	Estimated Small Fish PCB Concentration
No action	Up to 250 ppm PCBs
Dredging to 500 ppm	Up to 15 ppm PCBs
Dredging to 50 ppm	Up to 5 ppm PCBs
Dredging to 10 ppm	Up to 3 ppm PCBs
Dredging to 1 ppm	No significant further reduction

PCBs directly transferred to the water or washed into Lake Michigan via sediment transfer appear to currently run well under 100 pounds per year according to Hydroscience (7). In the past when OMC was actively discharging PBCs, several thousand (perhaps as much as 15,000) pounds per year may have been transferred to the Lake. This number compares with an estimated 10,000 to 15,000 pounds of PCB added to Lake Michigan from all other sources.

REFERENCES

(1) Bremer, K.,; et al., "State of Conarns of the Lake Michigan Toxic Substances Committee Related to Polychlorinated Biphenyls" (July 1975).

(2) Allen, J. R., et al, Toxical Appl Pharm 30: 440 (1974); also Arch. Environ Cont. Toxicol 2: 86 (1974); also subsequent articles.

(3) Kimbrough, R., et al, CRC Crit. Row. Toxicol 2: 445 (1974); also subsequent articles.

(4) Culhane, John "PCBs: The Poison That Won't Go Away", Readers Digest, December 1980.

(5) Griffin, R. A., and E. S. K. Chian, "Attenuation of Water-Soluble Polychlorinated Biphenyls by Earth Materials", EPA-600/2-80-027, May 1980.

(6) Environmental Control Technology Corporation (ENCOTEC), "Preliminary Evaulation of PCB and Water Movement - North Ditch. May 1977.

(7) Thomann, Robert V., "Mathematical Modeling Estimate of Environmental Exposure Due to PCB-Contaminated Harbor Sediments", Hydroscience, Inc., Contract No. 68-03-2568 (in preparation).

(8) Tofflemire, T. J., and Shen, T. T., "Volatilization of PCB from Sediment and Water: Experimental and Field Data", New York State Bureau of Water Research and Division of Air Resources (1979).

(9) Murphy, T. J. et al, "Polychlorinated Biphenyls in Precipitation in the Lake Michigan Basin", EPA 600/3-78-071, EPA Lab. Duluth, MN (July 1978).

(10) "The Analysis for Polychlorinated Biphenyls in Fish Collected in Waukegan Harbor", U.S. EPA Region V, internal report (1978).

(11) "Preliminary Evaluation of PCB and Water Movement - North Ditch", Environmental Control Technology Corp., May 1977.

(12) Noehre, Allen W., and Julia B. Graf, "An Estimate of Sediment Movement in North Ditch, Waukegan, IL", U.S. Department of Interior Geological Survey (1980).

(13) Dawson, G. W. and J. L. Goodier, "Evaulation of Alternatives for Removal/Destruction of PCB-Contaminated Sediments in Waukegan Harbor", Battelle, Pacific Northwest Laboratories, (1979).

(14) Tofflemire, T. J., "Improving the Efficiency of Dredging Several Feet of Contaminated Sediment off the Top of an Uncontaminated Sediment". New York State Department of Environmental Conservation Technical Paper No. 61. (Nov. 1979).

APPENDIX 3

WAUKEGAN HARBOR DREDGING AND DREDGE SPOIL TREATMENT PARAMETERS DEVELOPED FROM BENCH SCALE LABORATORY TREATMENT TESTS BY MASON & HANGER

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Mason & Hanger-
Silas Mason Co., Inc.

FOUNDED 1827

Lexington, Kentucky
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606-254-9383
CABLE CODE-MHSMCO

October 21, 1980

Mr. Howard Zar
Enforcement Division
United States Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604

Subject: Bench Scale Laboratory Test
Results - Waukegan Harbor Sediments

Dear Mr. Zar:

Mason & Hanger-Silas Mason Co., Inc. is enclosing three copies of our report presenting our bench scale laboratory test results on Waukegan Harbor sediments. These sediments were collected by Warzyn Engineering, Inc., July 1-3, 1980. The conclusions learned from these tests coupled with information from other sources will have a direct impact on design of a system or method for removing PCB - contaminated sediments from Waukegan Harbor.

Very truly yours,

MASON & HANGER-SILAS MASON CO., INC.

R. W. Cook, Jr., P.E.
Manager of Engineering

RWCJr:JSN:sgb

The following report, "Waukegan Harbor Dredging and Dredge Spoil Treatment Parameters Developed from Bench Scale Laboratory Treatment Tests", was submitted to the U.S. EPA in October 1980. Since this report was submitted,

(1) PCB contamination was discovered in the sand and underlying silty-clay at the OMC outfall in Slip #3 of Waukegan Harbor (silty-clay is a better description than hardpan clay).

(2) The cubic yardage of contaminated muck sediments were recalculated based on November 1980 measurements. A more conservative estimate had been made in this October report based on very limited information.

WAUKEGAN HARBOR DREDGING AND DREDGE SPOIL TREATMENT PARAMETERS DEVELOPED FROM BENCH SCALE LABORATORY TREATMENT TESTS

OCTOBER 1980

SUBMITTED TO ENVIRONMENTAL PROTECTION AGENCY
REGION V ENFORCEMENT DIVISION
CHICAGO, ILLINOIS

MASON & HANGER-SILAS MASON CO., INC.
1500 WEST MAIN STREET
LEXINGTON, KENTUCKY 40505

ABSTRACT

Mason & Hanger-Silas Mason Co., Inc. (Mason & Hanger) has reviewed data collected by the Environmental Protection Agency, University of Wisconsin, ENCOTEC, Energy Research Group, Inc., and others on the extent of polychlorinated biphenyl-contaminated soils and sediments at Waukegan Harbor and nearby North Ditch, Waukegan, Illinois. In addition, Mason & Hanger has completed bench scale laboratory tests of 5 gallon sized sediment samples collected at six locations in Waukegan Harbor by Warzyn Engineering, Inc. and has measured harbor sediment thickness at 22 locations.

From these laboratory tests and other information, Mason & Hanger concludes the following:

1. Harbor sediments consist of a (1) top soft "muck" layer, a (2) middle sand layer, especially in Slip No. 3, and an underlying clay (hardpan) layer.

2. Where PCB contamination occurs at any location, the entire muck layer is contaminated (with the possible exception of some locations towards the mouth of the harbor). Therefore harbor dredging is based on removing the muck layer down to sand. Possible penetration into sand has yet to be verified, expecially in Slip No. 3. Contamination has not penetrated the underlying clay.

3. The top muck sediments can easily be slurried with water, simulating a hydraulic dredge pumping the sediments to a lagoon.

4. At least two hours of settling are required before the water used to slurry the sediments can be further treated before discharge back to the harbor. Treatment consists of (1) adding a coagulant to settle colloids, (2) settling the coagulated solids in a sedimentation basin, (3) filtration at 3 gpm per square foot, and (4) carbon filtration (12 minutes detention). Laboratory tests demonstrated that the treated water should contain less than 1 part per billion PCB.

5. Several days of settling time or longer in a lagoon should be provided for the harbor solids to dewater to a point where they can be transported to a landfill.

6. Harbor core sample lengths cannot be reliably used to estimate muck layer thicknesses. Direct measurements of the muck layer showed the thickness to vary from 0 to 10.5 feet.

7. Mason & Hanger estimates 74,000 cubic yards of muck containing over 50 parts per million (dry basis) PCB located at the upper end of the harbor. This leaves 216,000 cubic yards of muck containing less than 50 parts per million PCB at other harbor locations. The 74,000 cubic yards of muck includes 15,000 cubic yards in Slip No. 3 with PCB concentration greater than 500 parts per million.

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1.0 INTRODUCTION

The U. S. Environmental Protection Agency, Region V has contracted with Mason & Hanger-Silas Mason Co., Inc. (Mason & Hanger) to estimate the cost of removal and disposal of polychlorinated biphenyl-contaminated soils and sediments at Waukegan Harbor and nearby North Ditch area, Waukegan, Illinois. The polychlorinated biphenyls (PCBs) are believed to have been discharged from the Johnson Motors Division of the Outboard Marine Company during the 1960's and probably during the early 1970's. Studies completed by various groups have defined the extent of contamination, at least to the point where very rough estimates of quantities of contaminated soils and sediments can be made. The removal and disposal plan for Waukegan Harbor calls for (1) dredging Waukegan Harbor using a hydraulic dredge (which will slurry water in with the contaminated Harbor sediments), (2) settling the harbor dredged solids in a lagoon or basin to be constructed, (3) disposal of the settled solids to a suitable landfill, (4) return of the supernatant (water) to the Harbor after removal of the solids, and (5) excavate and disposal of contaminated North Ditch soils to a suitable landfill.

The Environmental Protection Agency has requested that any water returned to Lake Michigan as a result of excavation operations (eg. dredging, storm runoff, etc.) be treated so as to remove PCB down to a level of one part per billion. Experience (Environmental Emergency Response Unit, Calgon, and others) dictates that this is feasible with carbon filtration using a 12 to 15 minute contact time if the water is prefiltered to remove suspended solids.

Mason & Hanger concluded, upon examining available reports in June 1980, that insufficient information was known on the properties of Waukegan Harbor sediments for design of a settling and dewatering treatment system. Therefore, Warzyn Engineering, Inc. (Madison, Wisconsin) was contracted to collect Waukegan Harbor bottom sediments at six locations so that Mason & Hanger could perform bench scale laboratory demonstration tests necessary to design the treatment system. In addition, Warzyn took split spoon core borings into the underlying cohesive clay in order to collect samples for PCB analysis. Duplicate sediment samples were taken at each of the six harbor locations for PCB analysis. Chain of Custody procedures were observed both for the samples delivered to Mason & Hanger for laboratory tests and to Raltech Scientific Service (Madison, Wisconsin), who was subcontracted to do the PCB analyses. Warzyn collected the samples July 1 and 2, 1980 (Dr. Harry Sterling witnessed the sample collection and Dr. John Nordin and Rom Payne ran preliminary screening tests on three of the samples collected; these are Mason & Hanger personnel). Warzyn submitted a report on their sample collection (report C 9291) dated August 5, 1980.

The original contract with Warzyn requested two additional soil samples be taken from the North Ditch area, which required entry on Outboard Marine Corporation property. Because permission to enter was denied during July 1-3, the U. S. EPA (Roscoe Libby) later collected the two samples for Mason & Hanger.

This report describes Mason & Hanger laboratory evaluation of the eight samples collected and how the samples were used to design a settling and dewatering and water treatment system.

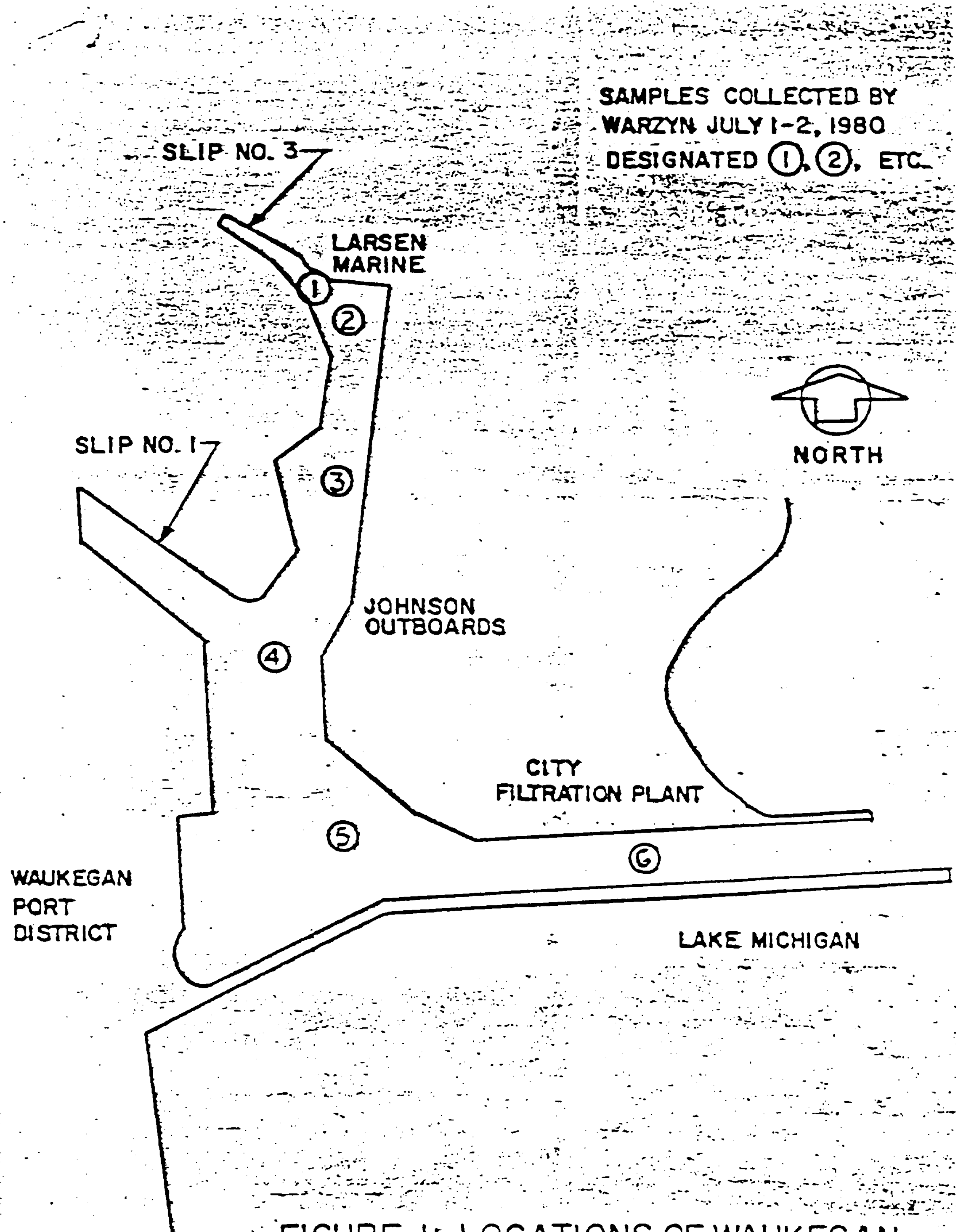

FIGURE 1: LOCATIONS OF WAUKEGAN HARBOR SEDIMENT SAMPLES

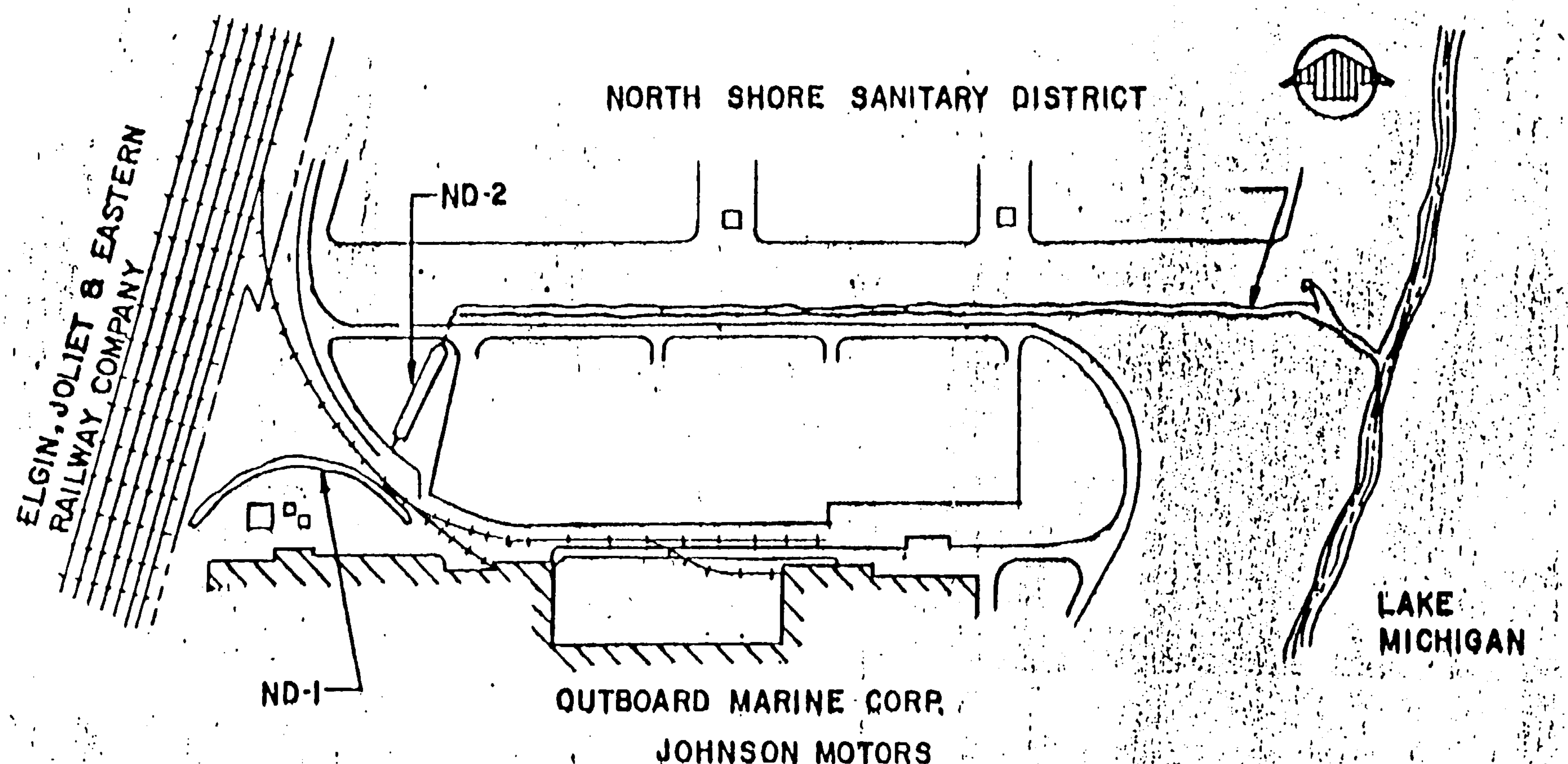

FIGURE 2: LOCATIONS OF NORTH DITCH SAMPLES ND-1 & ND-2 COLLECTED BY EPA JULY 1980

Figures 1 and 2 illustrate the locations of the samples collected.

During September 3-5, 1980, Dr. John Nordin accompanied EPA during a Waukegan Harbor sediment sampling program and measured sediment thickness at 22 different locations; he concluded that the six samples collected by Warzyn would be representative of the material which would be dredged from the Harbor.

2.0 DESCRIPTION OF LABORATORY TESTS PERFORMED

2.1 Initial Examination:

The six harbor sediments were delivered to Room 1017, EPA Enforcement Laboratory, on July 1 and 2, 1980; each sample was collected in a separate five gallon carboy and sealed with Chain of Custody tape. The two North Ditch samples were placed in separate 5 gallon containers using a clam shell digger to collect the samples and delivered to the Chain of Custody room of the EPA Enforcement Laboratory. Dr. John Nordin and Mr. Rom Payne examined sediment samples from locations 4, 5, and 6 on July 2. All samples were examined on August 12, 1980, after Raltech had time to complete some of the chemical analyses so a laboratory testing program could be planned. For all practical purposes, the samples examined August 12 appeared the same and behaved the same when slurried with water compared with the examination when collected fresh. One live red worm (annelid) 1.5 inches long was seen when the sample from location 4 was seen July 2. There was some degree of separation into a solid phase and a very turbid supernatant when the samples were examined August 12 after sitting six weeks.

Each sample was removed from the 5 gallon container and homogenized before dividing into portions for the various tests during the week of August 11. Sediment not used for the various tests were returned to the original container, which was placed in the Chain of Custody room at EPA Laboratory.

The sediments varied in color from a very dark grey to black. The samples from the North Ditch were obviously oily and were black. The samples could support a light weight of about 0.4 or 0.8 lbs. per square inch, but heavy weights of several pounds per square inch would sink. A 400 cc sample (location 1) placed in a 4 inch high by 3 inch diameter beaker deformed to a pile 2 inches high and about 5 inches in diameter when this beaker was turned over on a flat surface. Warzyn described the material as "very soft, black organic clayey silt, some sand present".

2.2 Raltech Scientific Service - Sample Analysis:

Warzyn delivered the samples from the six Waukegan Harbor locations, each sample in two 32 oz. glass containers with aluminum foil inserts for lids, to Raltech on July 3. The two North Ditch samples were delivered via Warzyn to Raltech on August 15. The 5 gallons for Mason & Hanger samples were homogenized to insure that the samples were uniform. Six cohesive clay samples from three Harbor locations (locations 1, 2, 3) were also delivered to Raltech on July 3. Chain of Custody procedures were used for all samples.

Table 1 lists the analyses as determined by Raltech. Two important conclusions can be learned from these analyses:

1. The PCB has not penetrated into the underlying clay, at least not at the three Waukegan Harbor locations.

2. The sediments themselves have a high organic content as indicated by oil and grease, COD, and volatile solids. PCB adsorption onto such sediments is irreversible (in contrast to adsorption onto sand which can be reversible). PCB separation methods employing detergents or anti-coagulant agents are not likely to work. Adsorption of PCBs onto soils is discussed further by Hague, et al, Environmental Science and Technology, page 139-44, Feb. 1974.

2.3 Physical Properties of Waukegan Harbor Sediments:

2.3.1 Density and Percent Moisture:

Density (grams per cubic centimeter) was measured by placing 300 cc of Waukegan Harbor sediments in a beaker of known weight and weighing the beaker. Results are in Table 2. Percent moisture was measured by Raltech (sample dried at 105 degrees C).

2.3.2 Sieve Analysis:

The 300 cc sediment sample weighted above was slurried with about 2000 cc of Lake Michigan water and passed through sieve sizes 5, 18, 35, 70, and 200 (Tayler Screen Scale Size). The screens were washed with extra water to aid in passing fines. The weight of the screens before and after passage of sediments were measured. The screens were tapped to remove excess water and were allowed to air dry for about 10 minutes before measuring.

The sediments retained by the Number 5 screen (0.03 to 13 percent) consisted of mostly debris, especially at location 1, with lesser amounts of small stones and gravel. The sediments retained by the other screen sizes were varing sizes of sand.

One of the hardpan clay samples (location 2, bottom of splitspoon) was slurried (with difficulty) with water and washed through the screens. Varying sizes of gravel and sand were retained by the indicated screens.

The results showed that approximately 75 percent of the sediments taken at location 3, 4, and 5 passed through a 200 mesh screen; 65 percent of the sediment at location 2 passed through a 200 mesh screen.

Warzyn Engineering, Inc. also completed screen size analyses on sediment samples collected at different depths at the same Harbor locations. Again, 75 percent or greater of the sediments taken at location 3, 4, and 5 passed through a 200 mesh screen. However, the sample taken at location 2 consisted of mostly sand which was retained by the screen. About 60 percent of the sample taken at location 1 passed through a 200 mesh screen (Warzyn).

2.3.3 Settling Density and Percent Solids:

The relative volumes of supernatant and settled sediment were measured August 11 after the six harbor sediment samples had settled six weeks. The samples were then homogenized and the density measured as in Section 2.3.1. Percent solids on a duplicate homogenized sample was done by Raltech (Table 1). The percent solids and density values were then corrected to give an ultimate settling density and percent solids. Mason & Hanger believes that these values would be representative of the density and percent solids that would be achieved if the dredging solids were lagooned for a long period of time before being hauled away to a landfill (without any additional dewatering by drying, freezing, or other methods).

2.4 Settling Column Tests:

A settling column, 4.5 inches inside diameter and 48 inches high, was constructed of plexiglass and fitted with 4 sample ports at 9 inch intervals for collecting water samples. The sediment sample was slurried with Lake Michigan water simulating the mixing which occurs during hydraulic dredging operations and placed in the settling column. Gravel and sand particles where present settled quickly to bottom of the column. After a few minutes, the muck began to separate leaving a turbid supernatant and a sludge. The interface between the supernatant and settling sludge was sharp; the height of this interface was recorded as a function of time over a period of approximately 16 hours. Water samples of the turbid supernatant were taken at periodic intervals for suspended solids analyses (performed by Raltech).

Settling column tests were completed using sediment samples collected at harbor locations 1, 4, and North Ditch location ND-1. Only 27 percent of the sediment at location 1 passed through a 200 mesh screen in contrast to location 4 where 75 percent passed through the 200 mesh screen. Only 3 percent of the sample collected at location ND-1 passed through the 200 mesh screen.

Figures 3, 4, and 5 presents a plot of the supernatant sludge interface layer height for the 16 to 18 hour tests. The sludge (muck) taken at harbor location 4 took longer to settle than the muck from location 1. Surprisingly, even the North Ditch sample ND-1 which contained mostly sand still contained many fines or muck and took some time to settle.

Suspended solid values (analyzed by Raltech) left in the supernatent are listed below:

	Test Sample		
	Harbor 1	Harbor 4	North Ditch ND-1
Initial Concentration	—	75,000	—
1 hour	660	2,700	140
2 hour	550	180	—
3 hour	—	73	88
4.5 hours	420	—	—
Overnight	110 (21.8 hrs.)	26 (17.5 hrs.)	58 (19 hrs.)

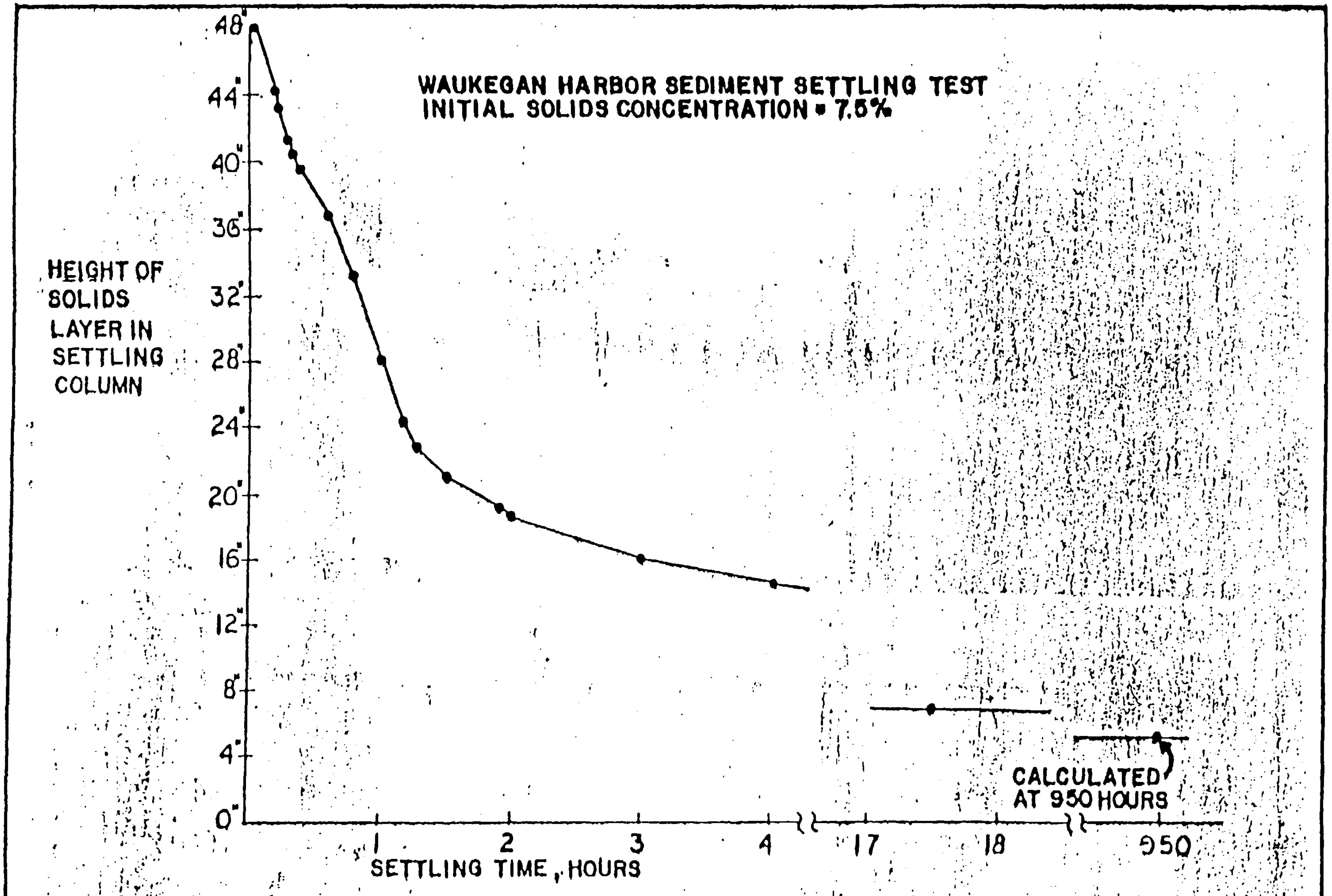

FIGURE 3: SOLIDS SETTLING TEST (LOCATION 4)

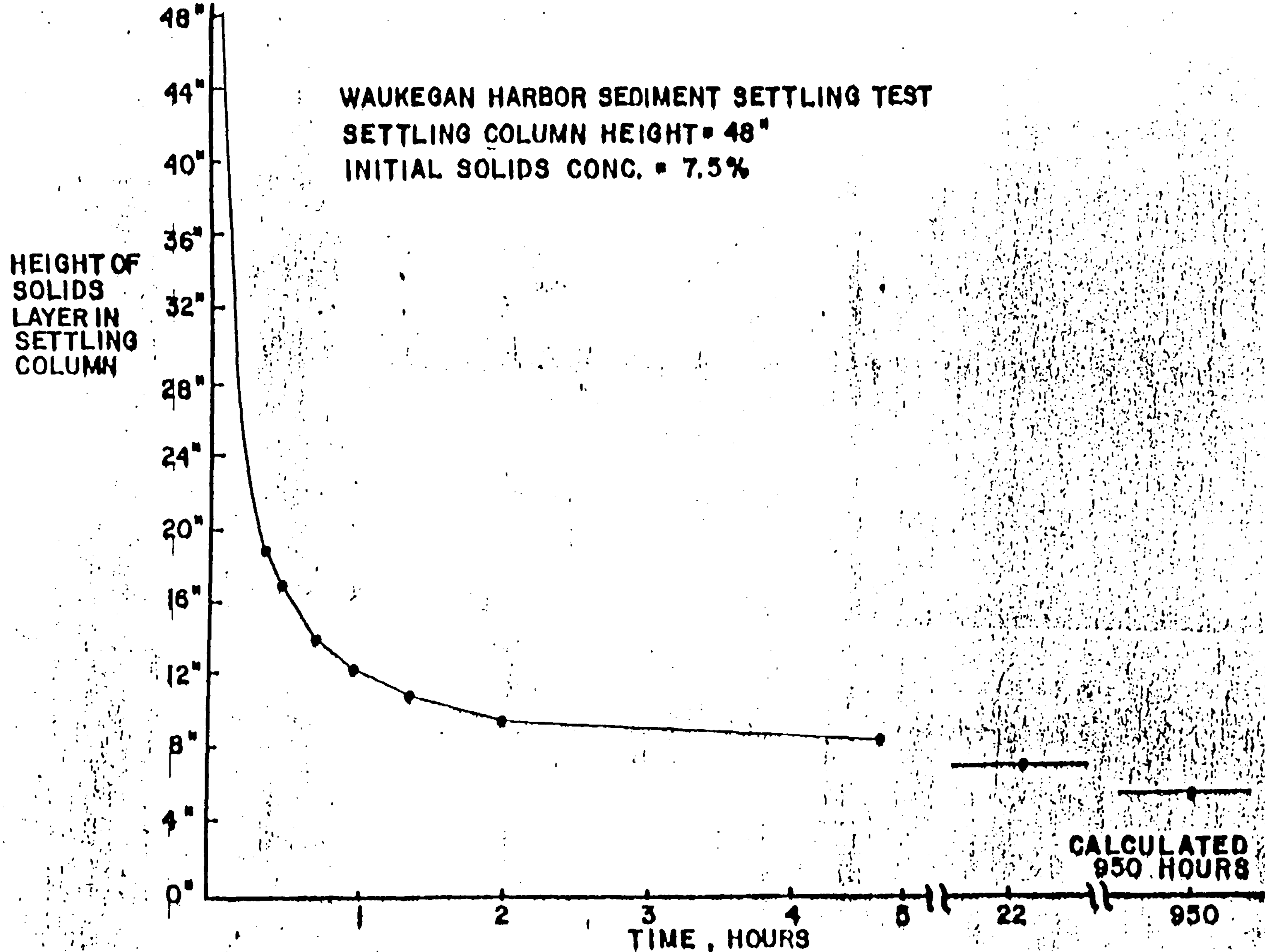

FIGURE 4: HARBOR SEDIMENT SETTLING TEST (LOCATION 1)

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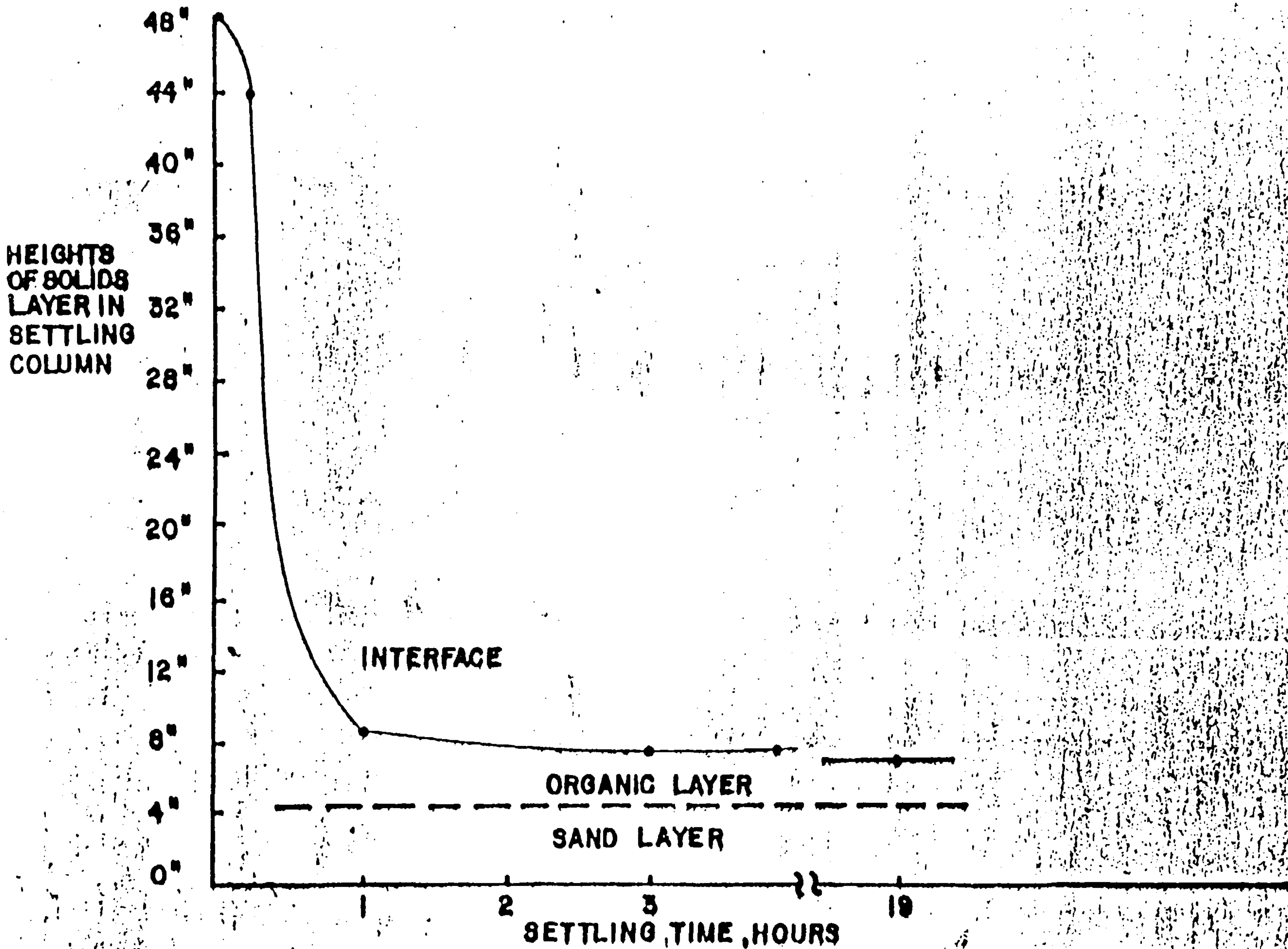


FIGURE 5: NORTH DITCH SOILS SETTLING TEST (LOCATION ND-1)

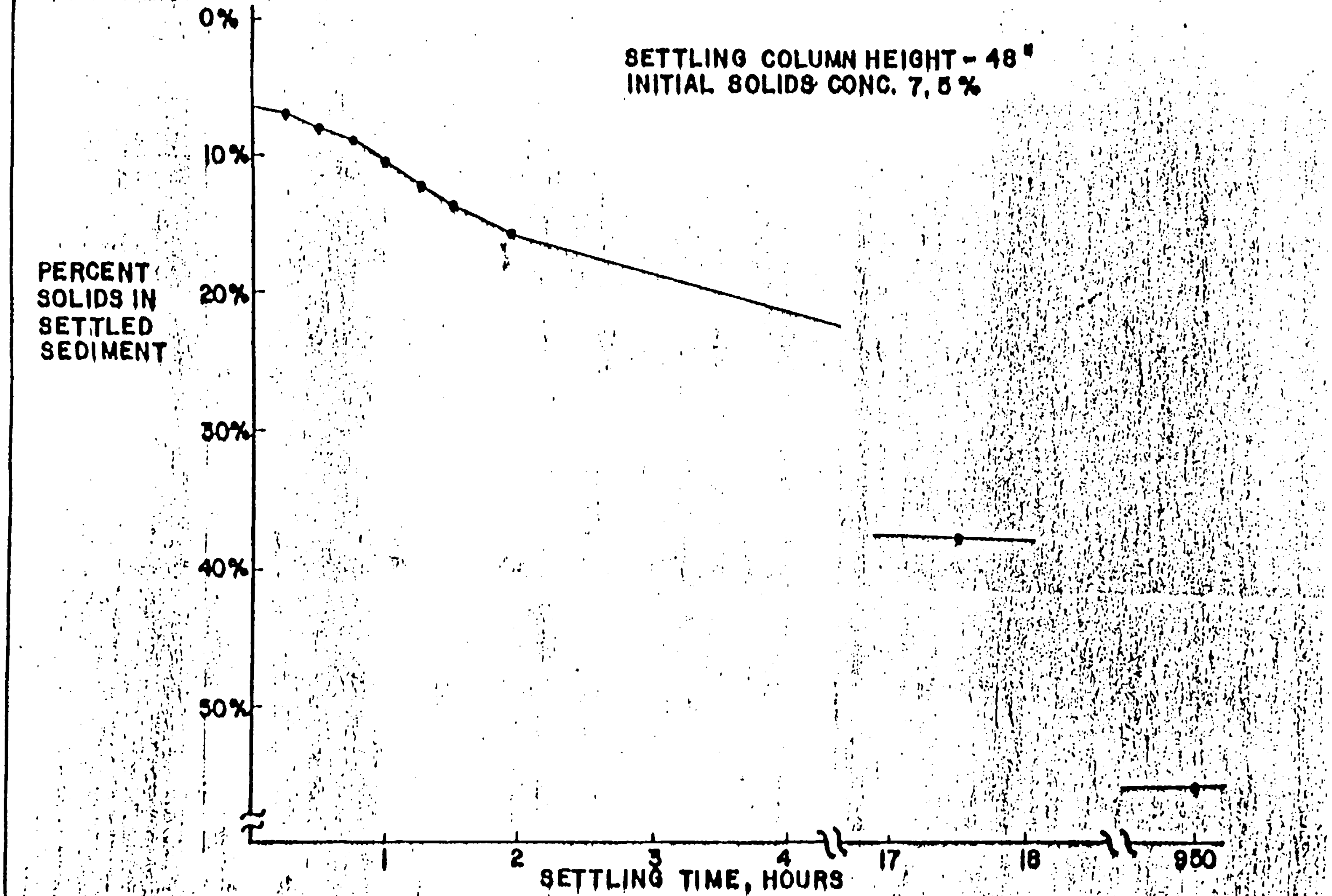


FIGURE 6: WAUKEGAN HARBOR SEDIMENT SETTLING TEST(LOCATION 4)

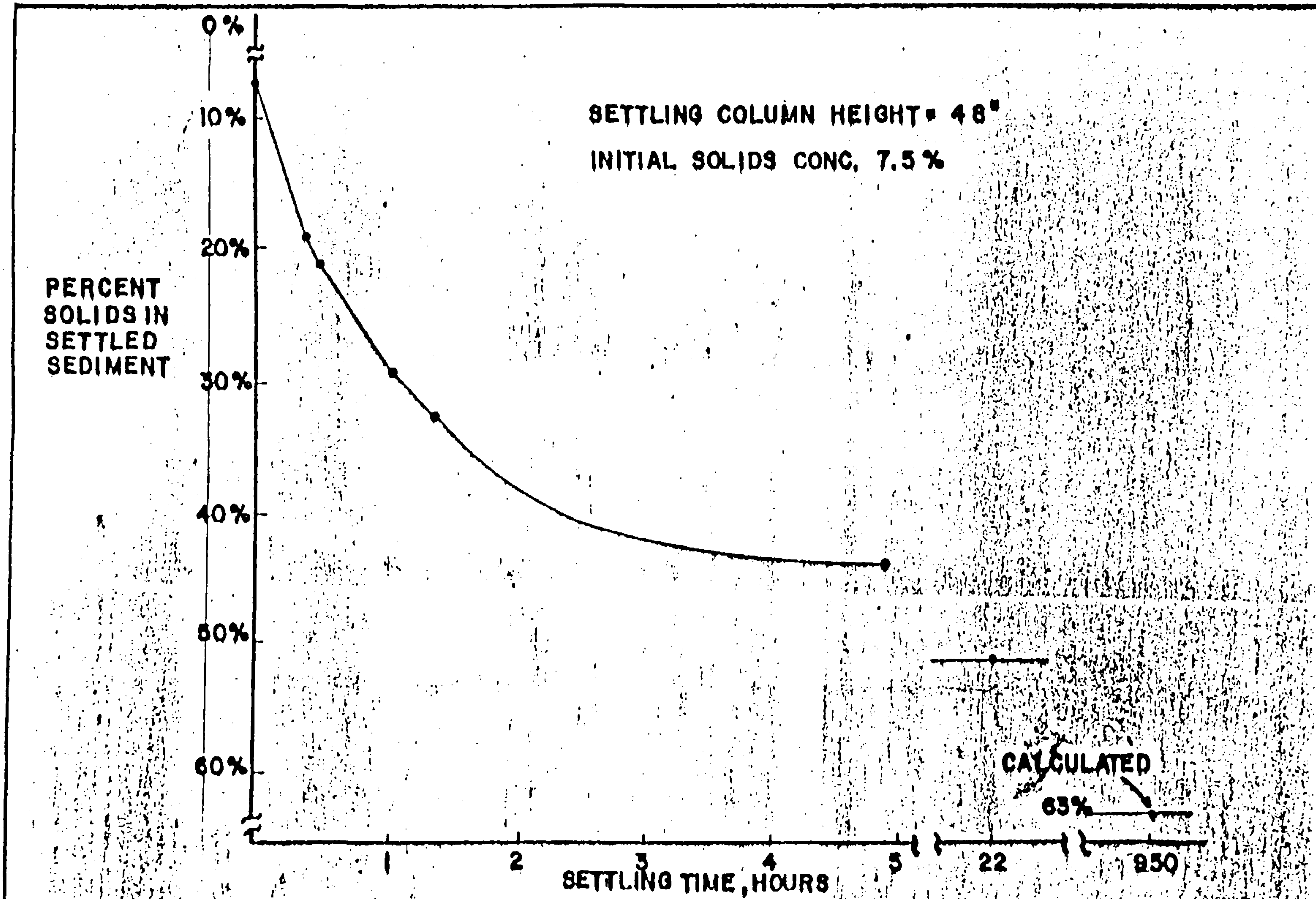


FIGURE 7: WAUKEGAN HARBOR SEDIMENT SETTLING TEST (LOCATION I)

Figures 6 and 7 present the average calculated percent solids of the settled muck (sludge) as a function of time. The percent solids were calculated knowing the initial percent solids and the interface height in the column. The values at 6 weeks were calculated as in Section 2.2.3. Mason & Hanger believe that Figures 5, 6, and 7 would be representative of the percent solids which would be hauled away to a landfill after settling in a lagoon for the number of hours specified.

2.5 Coagulation Tests:

Preliminary tests showed that the suspended solids left in the supernatant after settling of the sludge (muck) in Section 2.4 were fine enough that they would pass through a laboratory filter (2 foot bed depth, see Section 2.6). Therefore, a method had to be found to coagulate and precipitate these suspended solids.

The following polymers and materials were tried as coagulants:

Alum, dosages 30 ppm to 66 ppm
Calgon Cat-Floc 121, dosages 5 to 15 ppm
American - Cyaminad Magnifloc 587C dosages 5 to 15 ppm
Nalco 8103 dosages 5 to 15 ppm
Dow Separan AP 273 dosages 1 to 5 ppm
Nalco 7181 dosages 5 to 15 ppm
Calgon 2640 dosages 5 to 15 ppm
Calgon E20L dosages 5 to 15 ppm
Calgon 587C dosages 5 to 15 ppm
Each of above polymers at 5 ppm with 5 to 15 ppm alum.

The tests were run using supernatant from harbor sediment Number 1. Additional tests were completed using sediment sample 4, 5, 6, and North Ditch ND-1. The conclusions are as follows:

1. Either 45 ppm alum or 5 ppm of cationic polymer and 10 or 15 ppm alum will coagulate and settle the suspended solids.

2. The cation polymer Nalco 8103 will also coagulate and settle the suspended solids when used by itself at a dosage of 15 ppm (5 ppm dosage almost as successful as 15 ppm). Other cationic polymers when used by themselves were not as successful for removing turbidity as Nalco 8103. Any of the cationic polymers removed turbidity in combination with 15 ppm alum.

3. The anionic polymer (Dow AP273) had no effect, either used by itself or in combination with cationic polymers and/or alum.

4. The North Ditch ND-1 supernatant was easier to clarify and settle than the Harbor sediment supernatant. A 30 ppm alum dosage or a 5 ppm Nalco 8103 dosage (by itself) would settle the fines leaving a clear supernatant.

2.6 Filtration Tests:

The laboratory filter consisted of a 7/8 inch inside diameter glass column 4 feet long filled to a depth of 2 feet with filter media. A siphon maintained a constant 21 inch water head on top of the media; a valve at the base of the column controlled the flow at an equivalent of 3 gallons per minute per square foot. The filter media was washed for two hours with Lake Michigan water before being slurried into the column; several bed volumes of the Lake water were again passed through the column before the test began.

Initially, Mason & Hanger planned to run duplicate tests with columns containing sand and coke breeze as filter media. The sand (Fisher product number S-150) and coke breeze particle size distribution was measured (dry):

	Sand	Coke Breeze
Percent Retained on a No. 5 Screen	0	11.4%
Percent Passed by No. 5 but Retained by No. 18	0	68.0%
Percent Passed by No. 18 but Retained by No. 35	42.8%	20.3%
Percent Passed by No. 35 but Retained by No. 70	57.2%	0.3%
Percent Passed by No. 70 Screen	0	0
	100.0%	100.0%

However, the coke breeze proved to be too friable, breaking up into small fines when washed with Lake water. When placed in the filter column, Mason & Hanger was unable to filter even tap water after passing several bed volumes because of the tendency to break up into fines which plugged the filter and underdrain support (glass wool plug). The effluent water was blackened by fines. Therefore, all tests were performed using sand. Anthracite coal should also prove to be a suitable filter media, but was not on hand for testing.

Experience (Environmental Emergency Response Unit at Edison, NJ; Calgon Corporation; etc.) generally dictates that suspended solids with PCB adsorbed must be removed prior to carbon filtration if the carbon filter is to remove soluble PCB to less than one part per billion. Calgon Corporation does market a carbon surface wash system and can tolerate some suspended solids in carbon filter feed water, but this may not be true for all applications. Mason & Hanger has taken the position that the filter media must reduce the suspended solids down to a few parts per million or less for the system to work.

Mason & Hanger was unable to filter the muck (sludge) water mixture after settling the sand (see Section 2.4). The filter plugged almost immediately. The initial filtrate passing through was turbid before flow stopped altogether. The conclusion is that the muck must be settled before water is passed through the filter.

Mason & Hanger also tried to pass supernatant left from the column settling test (Section 2.4) after settling of the sludge without adding polymers or alum to settle the fines (Harbor location Number 1):

Filter Feed:	718 ppm suspended solids 11.0 ppm PCB (Aroclor 1242) 0.78 ppm PCB (Aroclor 1254)
Filter Effluent:	60 ppm suspended solids 1.05 ppm PCB (1242) 0.062 ppm PCB (1254)

The fines left in the supernatant also tended to plug the filter decreasing the filtration rate.

The test was repeated, but this time 5 ppm Nalco 8103 and 10 ppm Alum was added to the supernatant to settle the fines before filtration. The coagulation test was carried out in the settling column, again using the sediment from Harbor location 1 as the test material. After one hour of settling, the supernatant contained 66 ppm of suspended solids. At the end of two hours, the supernatant was withdrawn and passed through the settling column:

Filter Feed:	21 ppm suspended solids 0.22 ppm PCB (1242) 0.0037 ppm PCB (1254)
Filter Effluent:	1 ppm suspended solids 0.079 ppm PCB (1242) 0.0006 ppm PCB (1254)

This time, the sand filter did not plug as readily; about 8 liters were passed through the sand filter. The coagulated fines tended to remain in the top two inches of the filter.

The test was again repeated using 5 ppm Nalco 8103 and 10 ppm alum, this time using North Ditch ND-1 sample slurried with Lake water and allowed to settle in the settling column for two hours:

Filter Feed:	35 ppm suspended solids 3.75 ppm PCB (1242) 0.98 ppm PCB (1254)
Filter Effluent:	5 ppm suspended solids 0.132 ppm PCB (1242) 0.002 ppm PCB (1254)

Conclusions:

The tests show that sand filtration will remove suspended solids, but a coagulant (alum; alum and Nalco 8103; or Nalco 8103 only) is necessary to coagulate and settle fines prior to filtration. Coke breeze proved too friable to use as filter media. The sand is incapable of filtering the muck before settling.

2.7 Carbon Filtration Tests:

The carbon filtration test equipment and methods was the same as the sand filtration test equipment (Section 2.6) except that Calgon Filtrasorb 300 was used as filter media. The feed flow rate was adjusted to give a 12 second holding time in the carbon column. The filter media was washed with Lake water and several bed volumes of test feed water were passed through the columns before a sample (2 liters) was withdrawn for analysis. The test feed water was the effluent from the sand filtration tests (Section 2.6). Two test feed waters were run:

Waukegan Harbor Location 1

Carbon Feed:	1 ppm suspended solids 0.071 ppm PCB (1242) 0.0006 ppm PCB (1254)
Carbon Effluent:	$<$1 ppm suspended solids 0.0004 ppm PCB (1242) 0.0002 ppm PCB (1254)

North Ditch Location ND-1

Carbon Feed:	5 ppm suspended solids 0.132 ppm PCB (1242) 0.002 ppm PCB (1254)
Carbon Effluent:	$<$1 ppm suspended solids 0.0008 ppm PCB (1242) 0.0004 ppm PCB (1254)

The tests demonstrate that Harbor water when slurried with sediments can be treated by settling, coagulation, sand filtration, and carbon filtration, and returned to the Harbor meeting the one part per billion PCB criteria.

2.8 Percolation Tests:

Several unsuccessful attempts were made to determine a permability coefficient for the settled sludge from harbor location 1 and North Ditch location ND-1. The test sediment was slurried with Lake water to give a 5 or 10 percent solids concentrations (one test at 5 percent, a duplicate test at 10 percent). This slurry was placed in a 48 inch tall 7/8 inch inside diameter glass column with a one-inch filter sand layer at the bottom. The muck settled in the column over a 20 hour period as it did on the settling column test (Section 2.4). When the valve at the bottom of the column was opened, the flow quickly dropped off to essentially zero after an initial drainage of a few hundred cubic centimeters. When unsettled (5 or 10 percent solids) slurry was placed in the column several hundred cubic centimeters passed through the column initially (Harbor location 1); an additional 40 mls passed through the 3.7 square centimeter sand base between 5 and 22 hours after the start of the test, despite a 2 foot head of water on top of 25 inch sludge bed and 1 inch filter sand base in the column. After 22 hours, the water perculation rate through the sludge bed (now at 4.75 inches deep) was essentially zero. Time did not permit redesigning the test procedure to permit measurement of very small percolation rates.

Mason & Hanger conclude that underdrain systems of sand or gravel or other media placed in the bottom of a lagoon for dewatering sludge or settled sediment from the Harbor would be relatively useless.

The columns containing North Ditch sample ND-1 did yield a percolation rate. After 6 hours of settling, a sludge bed of 3.75 inches rested on top of the one-inch filter sand base. The percolation rate through the 3.75 inch sludge bed (average of two duplicate tests) with two feet of water head was calculated to be 1.06 gallons per hour per square foot of sludge bed. Time constraints did not permit continuing the test beyond 7.5 hours to see whether the percolation rate would decrease.

2.9 Conclusions:

1. The sediment samples collected at the six harbor locations proved difficult to settle and dewater after slurrying with Lake water. Any settling lagoon designed to receive dredging solids should preferably be designed to provide several days retention, and in any case not less than about six hours detention before solids are removed to a landfill. The longer the retention time provided, the greater the solids can be dewatered.

2. A coagulant should be added to the supernatant to settle colloids after initial settling of the slurried muck in the lagoon. Suitable coagulants are (a) 45 ppm alum, (b) 10 ppm alum and 5 ppm of certain cationic polymers, (c) 15 ppm of the cationic polymer Nalco 8103. Two hours of settling after coagulant addition should adequately settle the fines. Probably shorter settling times will work, but were not demonstrated in the laboratory.

3. Sand filtration (3 gpm/ft.^{2} followed by carbon filtration (12 minute retention) of the supernatant (after coagulant addition and settling) should yield a clean water containing less than one part per billion of PCB. This water can be returned to the harbor. Good filtration prior to carbon filtration is essential.

4. Lagoon underdrain systems of sand, gravel, or coke breeze appear to be inappropriate as an aid in dewatering lagoon solids, at least based on preliminary laboratory tests.

5. Coke breeze proved too friable to use as filter media.

3.0 EVALUATION OF WAUKEGAN HARBOR SEDIMENT DEPTH AND SAMPLING METHODS

3.1 Warzyn Report C9291:

The Warzyn Engineering, Inc. report C9291 submitted to Mason & Hanger in August 1980 presented sediment core boring results at each of the six harbor locations. Warzyn recognized these distinct layers at the bottom of the harbor, namely: (1) a top muck layer (described by Warzyn as a "very soft, black organic clayey silt, trace to some sand"), a (2) underlying "sand" layer especially in slip 3, and (3) a bottom clay layer ("described as "very stiff to hard gray silt, some clay, trace to some sand, trace gravel"). The sand layer becomes diffuse or almost non-existent as one proceeds towards the Harbor mouth. Depths from the surface of the water to the top of these three layers are listed below for each of the six Harbor locations (July 1-2, 1980):

	Muck	Sand	Clay
Location 1 (Slip 3)	15 feet	18 feet	21.6 feet
Location 2 (Slip 3)	18 feet	22.5 feet	24 feet
Location 3	19 feet	23 feet	24 feet
Location 4	22 feet	None	24.5 feet
Location 5	23 feet	None	25 feet
Location 6	23 feet	24 feet	24.5 feet

The samples used in the laboratory tests (Section 2.0) and for PCB analyses represented what was believed to be a uniformly-mixed muck sample down to sand, collected using a clam-shell sampler and Shelby tubes (see Warzyn report). The clam-shell sampler sampled the top sediments whereas the Shelby tube biased the lower, more dense sediments which the clam-shell sampler was unable to reach. The sediments by the two methods were mixed together to yield one homogeneous sample.

3.2 EPA Sampling Methods:

EPA Waukegan Harbor sediment sampling tube (2.5 inches outside diameter, approximately 0.25 inches wall thickness) containing a 2 inch diameter plastic liner. Two tube sections can be fastened together to permit up to eight feet of sample core to be collected. Typically, the 60 lb. sample tube and mechanism is lowered from a boat until several feet above the sediments, and allowed to drop into the muck. A second four foot tube section added another 22 pounds to the mechanism. Usually, this weight was enough to penetrate the entire muck layer down to sand or clay. Penetration to clay was confirmed by a one or two inch clay plug in the nose cone of the sample tube. The sediment sample was cut into five centimeter segments for analyses.

Water depths to top of sediments were measured using a three pound lead weight.

3.3 Other Sampling Studies:

3.3.1 University of Wisconsin Data (July 1980 Report):

Dr. David Armstrong reported that the University of Wisconsin used a Kahlsico Rectangular Box Sampler (manufactured by Kahl Scientific Instrument

Corporation, El Cajon, California) for two sample stations. The remainding stations were taken with a Ponar-type samper. Water depths were measured from the length of cable on the sampler when it positioned itself on the bottom of the harbor.

3.3.2 <u>Energy Research Group, Inc. (August 1979 Report)</u>:

Water depths were measured using a secchi disc. Sediment core samples were taken by the EPA (Section 3.2).

3.3.3 <u>Illinois EPA Studies (measured Feb. 16-18, 1977)</u>:

The sediment sampling device was a 100 pound split spoon assembly, each spoon 2.5 inches in diameter and screwed end-to-end and containing a continuous polyethylene line. The rod weight attached to the spoons was another 100 pounds.

Water depths were measured using a one foot area disc attached to the cable of the sampling device which was lowered until it touched bottom.

3.3.4 <u>Environmental Control Technology Corporation (ENCOTEC)</u>:

Harbor sediment core samples were collected in April 1977 using 6.7 cm outside diameter stainless steel thin wall tubes, assembled as open-ended Shelby tubes and then pressed and hammered to prescribed depths. Detailed boring logs were kept, and 80 percent recovery was considered the lower limit of acceptability. All sediment borings were made to the top of the clay layer underlying the area.

3.4 <u>Waukegan Harbor Sampling September 2-4, 1980</u>:

Arrangements were made for Dr. John Nordin (Mason & Hanger) to be with the Environmental Protection Agency personnel while they obtained sediment core samples (Section 3.2) at seven different harbor locations. Sediment depth measurements were taken at these locations plus 15 additional points selected by Mason & Hanger. The EPA core samples were designated 80VL11S01 through 80VL11S07. Mason & Hanger concluded (report in Appendix A) the following:

1. Depth measurements using the Secchi Disc, lead weight, or another weight borrowed from Falcon Marine gave the same answer. All weights rested on top of the muck layer and did not penetrate into the muck.

2. A 3/4-inch diameter pipe probe easily penetrated the top muck layer down to sand or clay and was demonstrated to be an effective tool in measuring the thickness of the top muck layer. Muck layer thicknesses varied from zero to 10.4 feet for the 22 Harbor points measured.

3. Muck samples collected at various depths "looked" for all practical purposes the same as the six muck samples collected by Warzyn for the laboratory tests. Seven of the samples are being analyzed by EPA for PCB content.

4. The amount of sample collected in the EPA core sample did not correlate with the depth the sampler penetrated into the muck, even if the core had a clay plug indicating clay was reached. Possibly because of the slight conical bottom shape of the EPA core sample, only some of the sediments (muck) went into the sampler and the rest was pushed aside as the sampler dropped into the muck. For example:

Location	Feet of Penetration into Muck or Muck Plus Sand	Feet of Sample Collected
80VL11S01	4.35	3.1
80VL11S02	2.8	1.5
80VL11S03	4.4	1.61
80VL11S04	0.2	0.2
80VL11S06	5.4	3.75
80VL11D06	10.4	5
80VL11S07	3.8	2.75

3.5 Conclusions:

1. Sounding data taken by Mason & Hanger (September 2-4, 1980), Warzyn (July 1-2, 1980), EPA (February 1977 and other dates), Argonne National Laboratory (November 21, 1978), U.S. Corps of Engineers (May 2, 5, 1980), and University of Wisconsin data (July 17, 1978) can be relied upon to estimate the water depth to the top of the muck layer, at least on the date of the test. The sounding equipment should not have penetrated into the muck to give a false reading.

2. Only the Warzyn data (July 1-2, 1980, 6 points), ENCOTEC, and Mason & Hanger data (September 2-4, 1980, 22 points) are useful for estimating the muck layer thickness down to sand or clay.

3. The sample core data (EPA, Argonne National Laboratory, and others) where PCB is measured are useful for mapping the extent of PCB contamination in the Harbor. The data generally indicates that where PCB contamination occurs, the entire muck layer down to sand or clay is contaminated. However, sample core length data cannot be used to calculate the muck layer thickness. Any attempt to do so would result in a low estimate of the cubic yardage of sediments to be removed. It is believed that this is a reason why Mason and Hanger estimates of amount of sediment to be removed are greater than most other estimates.

4. Therefore, the Mason & Hanger plan is based on removing all of the muck sediment layer at any given location down to sand or clay. An exception might be at areas such as location 80VL11D06 where the muck layer is very thick (10 feet) and far away from Slip 3 (possibly not all of the muck need be removed).

4.0 ESTIMATION OF QUANTITIES OF WAUKEGAN HARBOR SEDIMENTS TO BE REMOVED

Mason and Hanger calculations for estimating the quantities of harbor sediments to be removed are presented in the appendix. The calculations are based on removing all of the "muck" down to clay or sand at any given point but not removing any of the sand.

Waukegan harbor was "subdivided" into 12 sections; for convenience, the same 12 sections mapped on page 11 of Battelle Pacific Northwest Laboratories submitted to the EPA under contract No. 68-03-02552 (T2010) were used. In summary, the number of cubic yards of muck in Waukegan Harbor are listed below:

	Contamination Level, ppm PCB		
	Over 500 ppm PCB	Over 50 ppm PCB	Under 50 PPM
Location	Slip 3	Upper end of Harbor	Remainder of Harbor
Sections	12 only	9 thru 12	1 thru 7
Number of Cubic Yards	15000	74000	216,000

The total cubic yards of "muck" in the harbor is 74,000 plus 216,000 or 290,000. These figures supercede earlier estimates given to EPA in September 1980.

Areas 1, 2, and 6 "muck" PCB content are marginally close to 10 ppm. Areas 3, 4, 5, 7 and 8 contain definitely more than 10 ppm PCB but less than 50 ppm. Areas 1, 2 and 6 contain 47,000 cubic yards of muck and areas 3, 4, 5, 7 and 8 contain 169,000 cubic yards of muck.

TABLE 1
WAUKEGAN HARBOR AND NORTH DITCH ANALYSES
RALTECH SCIENTIFIC SERVICES, MADISON, WISCONSIN

Sample	Percent Solids	Percent Volatile Solids	Oil & Grease	COD	PCB (as is)	PCB (dry basis)
Sediment, Location 1	53.3	3.5	0.385	41,600	72.6	143
Sediment, Location 2	42.6	4.5	0.610	55,800	106	249
Sediment, Location 3	38.0	4.3	0.618	64,100	31	81.6
Sediment, Location 4	54.4	4.1	0.309	53,400	28.6	34.2
Sediment, Location 5	41.0	3.6	0.204	39,500	11.4	27.8
Sediment, Location 6	77.9	2.9	0.068	19,200	8.3	11.5
Clay (top), Location 1	89.6	Not Done	Not Done	Not Done	<1	<1
Clay (bottom), Location 1	89.8	Not Done	Not Done	Not Done	<1	<1
Clay (top), Location 2	87.1	Not Done	Not Done	Not Done	<1	<1
Clay (bottom), Location 2	87.7	Not Done	Not Done	Not Done	<1	<1
Clay (top), Location 3	88.7	Not Done	Not Done	Not Done	<1	<1
Clay (bottom), Location 3	88.6	Not Done	Not Done	Not Done	<1	<1
North Ditch, ND-1	32.6	3.9	4.16	39,800	1167	3580
North Ditch, ND-2	39.0	6.4	8.38	62,700	11050 (Aroclor 1242) 1257 (Aroclor 1254)	28330 (Aroclor 1242 3223 (Aroclor 1254)

Remarks: Percent Solids: Sample dried at 105 degrees C
Percent Volatile Solids: Sample dried at 550 degrees C
Oil & Grease: Percent oil and grease, dry weight (105 degrees C) basis
COD: mg/kilogram of sample as received
PCB: mg/kilogram of sample as received or on a dry weight (105 degrees C) basis (Arochlor 1242 unless otherwise stated)

TABLE 2
PHYSICAL MEASUREMENTS OF WAUKEGAN HARBOR SEDIMENT SAMPLES AND NORTH DITCH SAMPLES
MEASUREMENTS BY MASON & HANGER; PERCENT SOLIDS BY RALTECH

Location	Percent Solids (as collected)	Percent Solids (Settling)	Density (as collected)	Density (Settling)	Sieve Analysis, Percent				
					5	18	35	70	200
1 (Sediment)	53.3	63	1.40	1.51	13.04	21.38	27.02	52.34	72.70
2 (Sediment)	42.6	50	1.36	1.45	1.39	5.15	10.05	20.27	35.66
3 (Sediment)	38.0	44	1.30	1.36	0.35	1.78	3.87	9.15	24.15
4 (Sediment)	54.4	56	1.60	1.63	1,46	4.64	7.92	14,50	25,07
5 (Sediment)	41.0	47	1.29	1.35	1.74	3.22	6.54	13.25	27,85
6 (Sediment)	77.9	78	1.69	1.69	0.03	2,30	6.31	30.00	63.46
2 (Clay)	87.7	87.7	1.78	1.78	10.05	18.18	19.19	20.62	27.20
North Ditch ND-1	32,6	51	1.77	----	14.12*	19.62	28,22	75.23	87.78

Remarks:

Percent Solids (as collected): percent solids (by weight) of sample as collected from Harbor bottom.
Density (as collected): density (grams/cc) of sample as collected from Harbor bottom.
Percent Solids (Settling): calculated percent solids after settling 6 weeks.
Density (Settling): calculated density (grams/cc) after settling 6 weeks.
Sieve Analysis: percent solids retained by indicated Taylor Screen Scale Size

*No. 5 screen retained organic debris rather than gravel; the other screens retained sand.

APPENDIX

TRIP REPORT

Purpose of Trip: To Compare Methods of Measuring Sediment Depths at Waukegan Harbor, Illinois (MHSM Project 595)

Personnel Involved in Sampling:

Roscoe Libby - EPA
Steve Wynnychenko - EPA
Keran Waldvogel - EPA
Ron Lillich - EPA
Steve Mealman - ERG
John Nordin - MHSM

Schedule:

EPA scheduling called for resampling Waukegan Harbor sediments at seven locations (samples designated 80VL11S01 thru 80VL11S07) during September 2-4, 1980. Arrangements were made for John Nordin to be with EPA during sampling so that depth measurements may be compared by different methodologies. Depth measurements were taken at the 7 EPA sample points plus 15 points selected by MHSM. EPA core samples S01 thru S07 and Mason and Hanger location 5 were measured September 3. The remaining Mason and Hanger points (2A, 2B, etc., 1C, 6) were measured September 4. The EPA will determine PCB and percent moisture content of their core samples.

Depth Measuring Probes:

The following methods of measuring depth were compared at each of the locations:

1. Secchi Disc.

   The Secchi Disc is a wood disc 0.65 foot diameter 0.75 inch thick with 7 inch diameter 1/8 inch steel plate bolted on bottom. Pressure: 0.02 lbs./inch^2 on sediments.

2. Falcon Marine Weight with Plastic Basket

   This is a 3.4 lb. iron weight with a 2.04 square foot flat plastic basket attached. Pressure: 0.012 lbs./inch^2 on sediments.

3. Lead Weight

   This 1.4 lb. lead weight is used by EPA to measure sediment depths. Pressure: 0.43 lbs./inch^2 on sediments.

4. Pipe Probe

   A galvanized 3/4 inch diameter steel pipe connected in 10 foot sections was found to easily penetrate the top muck layer down to clay or sand.

5. EPA Core Sampler

A boat hoist lowered the 60 to 65 pound core sampler to a point several feet above the muck layer. The sampler was then allowed to drop by gravity into the muck, allowing a four or five foot core sample to be taken. At sample location 80VL11D06, another 4 foot section weighing about 22 lbs. was attached to the original 5 foot section in order to allow a 9 foot core sample to be taken. At sample locations 80VL11S01, 80VL11S02, and 80VL11S03, four core sampler sections (about 84 lbs) were tapped with a sledge hammer about 20 to 30 times in order to sample the uppermost sand layer.

Conclusions:

1. The Secchi Disc, Falcon Marine weight, and lead weight gave the same depth measurement. Minor differences in a few readings were traced to slight drifting of the boat or an uneven bottom (verified by repeat readings). Depths measured by these weights represented the depth to the top of the muck layer. None of these weights penetrated the muck. Depth measurements were unaffected by Curly Leaf Pond Weed which grows abundently in slip 3.

2. The pipe probe easily penetrated the muck (sediments) down to the clay or sand layer. The boundary between muck and sand or clay was (in almost all cases) very sharp and could be easily measured within an inch or two. With practice, John Nordin was able to distinguish between sand or clay by the "feel" of the probe. Also, a clay plug would be seen when the pipe probe was removed from the water if clay were reached.

3. The concept of a separate organic muck layer and a sediment layer is an erroneous one. Basically, there is a muck layer, a sand layer, and a clay layer. At many locations, the muck extends down to the clay (hardpan) with no intermediate sand layer. The muck may, of course, have some sand in it; and in slip 1, the bottom sand layer seems to be mixed with clay.

4. Usually, the EPA core sampler will penetrate the muck down to sand or clay. However, if the muck is exceptionally thick, or the core sampler is dropped from insufficient height, the core sampler will only partially penetrate the muck. Unless verified by the pipe probe, the only evidence of complete penetration of muck is a clay or sand plug in the bottom of the core sampler.

5. The amount of sample collected in the EPA sample probe does not correlate with the depth to which the sample probe drops into the muck.

6. The muck for all practical purposes "looked" and "felt" like the muck collected July 2-3 1980. The July 2-3 muck is believed to be representative of the material which would be removed from the harbor (density, screen size, percent moisture, settling time, etc.).

Possibly because of the conical bottom shape of the EPA core sampler, only some of the sediments (muck) goes into the sampler as it drops into the muck. The rest of the sediments (muck) is pushed aside. The following table shows no relationship to the EPA core collected to the depth the EPA core sampler penetrated the muck:

Location	Depth to Muck	Depth to Sand or Clay	EPA Sampler Depth	EPA Core Collected
80VL11S01	12'	15.7' (sand)	16.35'*	3.1'
80VL11S02	11.9'	14.35' (sand)	14.7'*	1.5'
80VL11S03	11.5'	14.7 (sand)	15.9'*	1.61'
80VL11S04	23.0'	23.0' (clay)	23.2'	0.2'
80VL11S05	24.75'	26.35' (sand)	26.7'	1.6'
80VL11S06	19'	28.15' (clay)	24.4'	3.75'
80VL11D06	17.6'	28' (clay)	28'	5'
80VL11S07	20.3'	24.4' (clay)	24.1'	2.75'
2B	19.95'	22.45'(sand-clay)	22.5'	1.5'
2C	23.2'	26.45'(sand-clay)	25.2'	1.2'
4A	15.15'	16.65' (sand)	16.0'	0.68'
4C	20.7'	26.55' (clay)	25.55'	3.4'
4D	18.4'	23.4' (clay)	23.1'	2.75'
6	18.75'	23.75' (clay)	23.75'	3.4'

The writer (J. S. Nordin) believes that it may be necessary to remove all of the muck down to clay at most locations, separating the muck (according to location) into categories greater than or less than 50 ppm. An exception might be areas such as location 80VL11D06 where the muck layer is very thick (10 feet) and away from slip 3 (possibly not all of the muck need to be removed).

Recommendations

1. Until more definite data is obtained, Mason & Hanger should plan to remove all of the muck layer down to sand or clay at those locations where PCB exceeds 10 ppm.

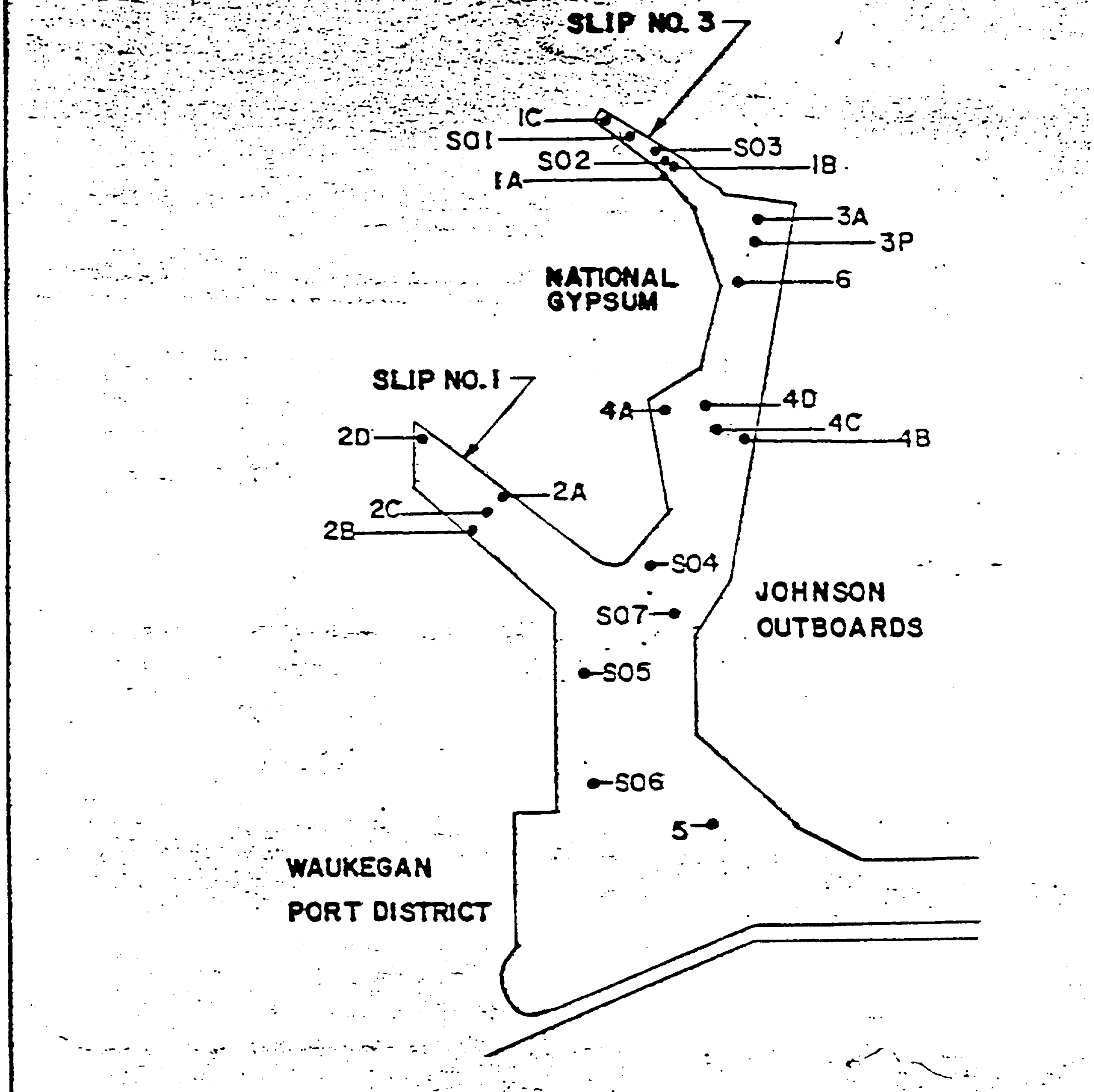
2. All EPA data (eg. in the ERG report) where depths are reported in meters were taken with the lead weight and can be relied upon to estimate the water depth to the top of the muck. However, Mason & Hanger should not add the "core depth" onto the water depth reading to estimate the quantity of sediments (muck) to be removed. Mason & Hanger can assume (for practical purposes) that the core sampler has penetrated the muck, and if all samples show high (greater than 10 ppm) PCB, then all of the muck must be removed.

3. Urgently needed is a mapping of muck thickness in Waukegan Harbor.

4. Urgently needed are PCB analyses in the sand layer especially in slip 3 as a function of depth down to clay. Sand thickness should also be measured for the various locations.

WAUKEGAN HARBOR DEPTH MEASUREMENTS
SEPTEMBER 3-4, 1980 EPA & MASON & HANGER
WATER LEVEL 579.62' Sept. 3
579.87' Sept. 4
ALL MEASUREMENTS IN FEET

Location	Secchi Disc Feet	Falcon Marine Basket, Feet	Lead Weight Feet	Pipe Probe Feet	Type of Material at End of Pipe Probe	EPA Core Sampler Feet	Description of Core Collected	Calculated Muck Depth	Remarks
80WL11801	12.0	12.8	11.3	15.7	Sand	14.9 drop; 16.35 after 18 blows	0.6' sand plus 2.3' muck	3.7'	Sand below muck Sand below muck
80WL11802	11.95	12.8	11.8	14.35	Sand	13.85' drop; 14.7' after 25 to 30 blows	0.2' sand + 1.3' muck	2.45'	Sand below muck
80WL11803	11.3	11.5	11.65	14.7	Sand	14.8' drop; 15.9' after blows	0.9' sand + 0.71' muck	3.2'	Sand below muck
80WL11804	23.1	23.0	-	-	-	23.2'	0.2' clay. No muck	0	Exposed clay
80WL11804	-	-	-	-	-	24.0	0.2' clay, 0.55' muck	0.55'	Clay below muck
80WL11805	24.7	24.75	-	26.35	-	26.7'	1.6' muck, some sand at bottom	1.6'	Sand below muck
80WL11806	18.7 Repeat 19.4	19.4	18.9	28.15	Clay	24.4'	3.75' of muck	9.15'	Clay below muck
80WL11806	17.6	17.6	18.0	-	-	28'	Clay plug plus 3' muck	10.4'	Clay below muck
80WL11807	20.3	20.8	20.1	26.4	Clay	26.1'	Clay plug + 2.75' muck	6.1'	Clay below muck
3	26.8	-	26.8	28.1	-	-	-	1.3'	
1A	23.7	23.75	23.21	25.45	Clay	-	-	1.75'	Clay below muck
2B	20.0	20.0	19.9	22.45	Sand & Clay	22.3	Clay-Sand plug plus 1.3' muck	2.5'	Clay-Sand below muck
2C	23.2	23.25	23.05	26.45	Sand & Clay	25.2	1.2' of muck and sand	3.25'	Clay-Sand below muck
2D	15.1	16.9 repeat 14.8	13.9	15.75	Sand & Clay	-	-	0.6' Uneven	Clay-Sand below muck Uneven bottom
4A	15.2	15.2	14.8	16.83 16.5 repeat	-	16.0	0.68' of muck and sand	1.5'	Sand below muck
4B	21.0	20.9	20.6	22.35	Gravel & Clay	-	-	1.75'	Gravel-Clay below muck
4C	20.8	20.7	20.7	26.35	Clay	25.55	3.4' of stiff oily muck	5.85'	Gravel-Clay below muck
4D	18.3	18.2	18.6	23.6	Clay	23.1	2.75' of stiff oily muck	5'	Clay below muck
3A	12.1	12.3	11.5	13.62 14.3 repeat	Sand-Gravel	14.0	lost core sample	1.8'	Sand below muck
3B	16 17.5 repeat	17.5 17.0 repeat	16.6	18.35 19.35 repeat	Sand	-	-	2'	Sand below muck
1A	6.9	6.9	6.5	7.9	Sand	8.55 7.45 repeat	lost core sample	1'	Sand below muck
1B	12.3 12.0 repeat	12.9 12.45 repeat	11.6	13.8	-	12.5	lost core sample	1.3'	Sand below muck
1C	7.4	7.5	7.2	11.3	Sand	-	-	3.9'	Sand below muck
4	19.8 18.9 repeat	18.4	18.0	-	-	23.75	3.4' of stiff oily muck	5'	Clay below muck



LOCATION OF WAUKEGAN HARBOR

DEPTH MEASUREMENTS - SEPTEMBER 3-4, 1980

APPENDIX 4

FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE C 9400
BY WARZYN ENGINEERING CO., INC.

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER
4765
AIPG
DANIEL W. HALL

Daniel W. Hall

FINAL SITE SELECTION
AND EVALUATION FOR A HAZARDOUS
WASTE DISPOSAL SITE
C 9400

WARZYN ENGINEERING INC

Consulting Engineers • Civil • Structural • Geotechnical • Materials Testing • Soil Borings • Surveying

1409 EMIL STREET, P.O. BOX 9538, MADISON, WIS. 53715 • TEL (608) 257-4848

December 23, 1980
C 9400

Mason and Hanger
Silas Mason Company Inc.
1500 W. Main St.
Lexington, KY 40505

Attention: Dr. Harry J. Sterling

Re: Final Site Selection and Evaluation for a Hazardous Waste Disposal Site

Gentlemen:

We are pleased to submit five (5) copies of the report, "Final Site Selection and Evaluation for a Hazardous Waste Disposal Site". This report supplements the report submitted to you on October 29, 1980, titled, "Preliminary Screening Assessment, Site Selection and Evaluation for a Hazardous Waste Disposal Site", per our contract agreement.

This final report evaluates the potential for hazardous waste disposal at the Browning-Ferris Industries (BFI) site, the CECOS (CER) - Williamsburg, Ohio site and on-site disposal and abatement alternatives at the Outboard Marine Corporation (OMC) property. The sites are evaluated from environmental, socio-economic and engineering points of view, with the major emphasis on the engineering aspects of the site.

If you have any questions or comments about the report, please contact us.

Very truly yours,

WARZYN ENGINEERING INC.

Daniel W. Hall

Daniel W. Hall, CPGS
Project Manager

DWH/dkp
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TABLES

APPENDICES

FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE

INTRODUCTION

The purpose of this study was to perform final evaluations of potential disposal alternatives for PCB contaminated dredge material disposal. The sites considered in this final evaluation include the Browning-Ferris Industries (BFI) landfill site near Zion, Illinois, the Clermont Environmental Reclamation (CECOS) landfill site near Williamsburg, Ohio and the Outboard Marine Corporation (OMC) property. Location maps for these sites were submitted in a previous report, "Preliminary Screening Assessment, Site Selection and Evaluation for a Hazardous Waste Disposal Site", dated October 29, 1980.

The BFI and CECOS sites were selected for the final evaluation based on a preliminary screening assessment of several potential land disposal sites identified by USEPA and Mason Hanger-Silas Mason Company, Inc. At the OMC property, in-situ abatement of the PCB contaminated sediments was recommended by Warzyn Engineering Inc. Mason Hanger-Silas Mason Company, Inc., further recommended that alternative on-site disposal methods be evaluated, including landfilling and lagooning of the PCB contaminated sediments.

Each of these disposal alternatives is evaluated with respect to its environmental, socio-economic, engineering and transportation characteristics and the costs associated with the development and use of each site for PCB contaminated dredge disposal. This evaluation process identifies the sites with the greatest potential for development as a waste disposal facility. Furthermore, the report identifies what additional data is required to prepare detailed engineering design of each of the recommended sites in this final evaluation, and finally, the procedure required for permitting the selected sites is presented. Mason Hanger-Silas Mason Company, Inc., has assisted in the final evaluation of the disposal alternatives evaluated in this report by providing Warzyn Engineering Inc., with specific data regarding the volume and concentrations of contaminated PCB sediments in the Waukegan Harbor area and on the OMC property that potentially need removal and disposal and/or abatement treatment.

Warzyn Engineering Inc., was authorized for this final evaluation investigation by Mason and Hanger-Silas Mason Company, Inc., by a subcontract agreement dated August 21, 1980. Mason and Hanger-Silas Mason Company, Inc., in turn, is contracted to USEPA, Region 5, to present results of this and other associated investigations regarding the OMC-Waukegan Harbor PCB contamination problem.

RESULTS OF PRELIMINARY SCREENING ASSESSMENT

The results of the preliminary screening process were presented in a report to Mason and Hanger-Silas Mason Company, Inc., titled "Preliminary Screening Assessment, Site Selection and Evaluation for a Hazardous Waste Disposal Site", dated October 29, 1980. The original scope of work outlined for the preliminary screening included four privately owned land disposal sites and three government owned sites to be considered for PCB contaminated sediment disposal. However, the site management of two of the privately owned sites (the C.I.D. landfill site in Cook County, Illinois and the Ottawa-Brockman Site-CECOS site near Ottawa, Illinois) eliminated their sites from the preliminary screening process, therefore, they were not considered in the assessment. In addition, two other privately owned landfill sites were preliminarily evaluated by telephone inquiry, which included the Nuclear Engineering site in Sheffield, Illinois and the Waste Management, Inc., site in Livingston, Alabama. The OMC property was not considered in the preliminary screening assessment along with the other sites, as it was determined that it would undergo the final site evaluation, and therefore, did not need a preliminary screening. Each of the sites that were subjected to the preliminary assessment were evaluated on selected physical/environmental and socio-economic criteria, as outlined in the scope of work and included; topography, soils and bedrock; groundwater and surface water; site engineering and operations; haul distance to site, traffic patterns and neighborhood characteristics; and the acceptability and availability of each site as a PCB contaminated dredge material disposal facility. The data gathered to assess the sites was provided by the landfill site owners and/or their consultants and the appropriate government agencies.

As a result of the preliminary screening process, the following summary and conclusions were presented in the October 29, 1980 report by Waryzn Engineering Inc.:

1. The BFI site should be included in the final site evaluation for potential PCB contaminated dredge disposal at that site.

2. The CECOS site at Williamsburg, Ohio is conditionally recommended for the final site evaluation after a study is performed to determine the hauling costs to the site from the Waukegan Harbor Area relative to the anticipated costs of site development at other, closer sites, specifically, the BFI site.

3. We do not recommend that the Joliet Army Ammunition Plant, Fort Sheridan or Great Lakes Naval Base be considered in the final evaluation of the sites, based on the premise that the sites would have to be completly redeveloped from the initial feasiblity to the final engineering phases, which is costly and time consuming.

4. We recommend that the Sheffield, Illinois site (telephone inquiry) be further investigated at the preliminary screening level.

5. We do not recommend that the Livingston, Alabama site (telephone inquiry) be further investigated at the preliminary screening level, based on the haul distance to the site, while other, closer sites are available.

RESULTS OF FINAL SITE SELECTION AND EVALUATION

A. Browning-Ferris Industries (BFI) Site (Option 1)

1. Introduction

Presently, BFI operates a licensed hazardous waste disposal site on approximately 59 (of 70) acres in the NW 1/4, Section 7, T46N, R12E, Lake County, Illinois and is located about 12 miles from the Waukegan Harbor area by roadway distance. The site is presently not permitted to accept PCBs and would require licensing from both the State and Federal Governments to do so. An adjacent 74 acre expansion site is presently permitted for development by the IEPA, however, it does not yet have an operational permit.

2. Environmental Characteristics

a. Regional Setting

Topography in the vicinity of the site varies from nearly flat to gently rolling. Elevations typically range between 760 feet and 590 feet MSL, such that the ground surface slopes eastward toward Lake Michigan. The area is underlain by a series of glacial tills, comprising a total thickness of at least 200 feet. The tills are underlain by Silurian dolomite bedrock.

Groundwater typically ranges from 5 to 20 feet below ground surface in the vicinity of this site. Regionally, groundwater flow is eastward toward Lake Michigan in the dolomite aquifer and at depth within the glacial till formation, however, locally, groundwater flow is toward the Des Plaines River or it's tributary, or toward Lake Michigan. The area is somewhat poorly drained such that occasional marshy areas occur, particularly along Lake Michigan.

b. Site Hydrogeology

Topographic relief at the site is on the order of 30 feet, ranging from about 755 feet MSL in the northern portion of the site to about 725 feet MSL in the southwestern corner, which generally meets USEPA requirement of low to moderate relief.

Soil borings from the site indicate about 0.5 feet to 1 foot of dark, silty/clayey topsoil is underlain by about 5 feet of moderately plastic, silty clay (CL-CH), underlain by a brown to gray, low plasticity silty clay (CL) to a depth of at least 50 feet to 70 feet below ground surface (687 feet MSL). Interlayers up to 3 feet thick of silt (ML), clayey silt (ML-CL) and silty and clayey sand (SM-SC) occur in the clay soils. Apparently, a continuous layer of silt and sand extends east from the eastern border of the existing site under the adjacent 74 acre site, ranging from 2 feet to 15 feet in thickness, lying 40 feet to 60 feet below ground surface (690 feet to 718 MSL).

Constant head permeability tests on eight samples of the clay from depths ranging 20 feet to 42 feet below ground surface range from 1.9×10^{-6} to 1.1×10^{-8} cm/sec, averaging 4.3×10^{-7} cm/sec, while falling head permeability tests on eight samples from 20 feet to 32 feet below ground surface at the proposed site indicate the range of 1 x 10^{-7} to 6 x 10^{-9} cm/sec, averaging 2.4 x 10^{-8} cm/sec. Cation exchange capacities of the clays are low (approximately 3 to 6 meq/100 grams).

The soils generally meet the thickness requirement of USEPA (4 feet) and Illinois EPA (10 feet). The soils generally meet the USEPA soil permeability requirement (1 x 10^{-7} cm/sec), however, marginally meet the Illinois EPA requirement (1 x 10^{-8} cm/sec). Recompaction of the clay soils could lower the permeability to 10^{-8} cm/sec or less. LL and PI were not measured as required by USEPA criteria. All samples tested of the silty clay exceed the USEPA 30% P200 requirement. USGS indicates this area is suitable for disposal of all wastes except mobile, unattenuated, hazardous substances.

Dolomite bedrock is located about 200 feet below ground surface. The dolomite is an important aquifer which is locally used as a source of drinking water.

Groundwater is reported to exist between 11 feet and 17 feet below ground surface at the existing site and 6 1/2 feet to greater than 12 feet below the proposed site. Groundwater flow direction was not reported, although flow direction is likely in a southerly direction. Depth to groundwater does not meet the USEPA requirement of at least 50 feet to the historical high water table below ground surface.

Judging from the topographic position of the landfill site, it may be in a local groundwater recharge zone, as it occupies a locally high topographic area and is surrounded by potential discharge points; Des Plaines River to the west, lowlands to the south and Lake Michigan to the east. According to USEPA requirements, a recharge zone should be avoided, however, because of the thick sequence of clay at the site, recharge characteristics are probably minimal. Drinking water is obtained primarily from the dolomite bedrock aquifer. At least two private residences with deep wells are located along 9th Street at the southern boundary of the site; several other residences are also located within 500 feet of the site boundaries along 9th Street, which also may have private well water supplies.

No natural streams, ponds or lakes occur on this site. Topographically, the site appears to lie near a surface water divide, such that surface water west of the site drains toward the Des Plaines River and east of the site toward the Lake Michigan basin. Surface drainage across the site is reported to be predominantly west and south. The site is not located within the 100 year flood plain, however, standing water has apparently occurred in the past near the northern portion of the site, probably due to poor soil drainage characteristics of the clays.

c. Socio-Economic Profile of the BFI Site

When considering the environmental impact of a project on an area, it is important to also consider the qualities of that area in relation to the social and economic environment. Construction and operation of a new PCB disposal area or disposal at an existing solid waste disposal site will exert both short and long-term impacts on that environment. Short-term effects will result from transportation, construction and disposal activities, whereas long-term effects will result from leachate collection and abatement, and commitment of the landfill area to that use. The following section will briefly discuss disposal of the PCB waste at the Browning-Ferris Industries site and the relationship of selected socio-political criteria to that option.

Existing land use surrounding the BFI site can be described as rolling farm land and forest. A subdivision approximately 1/2 mile southeast from the site and several private residences are located in the surrounding vicinity but the population is sparse near the landfill site. Two other existing landfill sites are present nearby. These are the American Ad-Mixtures site and North Shore Sanitary District site.

There are several potential haul routes available from the OMC harbor area to the disposal site. The preferred route would utilize State highways and minimize travel through residential areas north of the Waukegan Harbor area. The route would follow Highway 132 (Grand Avenue) west 3 1/2 miles to Highway 131 and proceed north for 7 1/2 miles to Ninth Street, for a short distance to the Highway 131 entrance to the landfill site, or a total of about 12 roadway miles.

Disposal of the PCB wastes would not create additional employment opportunities at the landfill site, although additional employment would be necessary to excavate and remove the PCB wastes from the harbor area and/or the OMC property. It is expected that transportation of the waste material to the BFI site would provide employment for a local transporter of wastes. No jobs will be lost as a result of the disposal of the PCB wastes at the BFI site.

Since the BFI site is an existing landfill, no change in taxation or land use can be expected. There will be no additional burden on public facilities, such as schools, hospitals, police departments, fire departments, etc.

There is no local zoning ordinance that prevents PCB disposal at the BFI site. However, due to the emotional issue of uninformed landowners not wanting to live near a hazardous waste disposal area, public opposition can be expected to the proposal. The site owners do not expect that that local opposition will prevent the disposal of the PCB dredge materials at the site.

Browning-Ferris Industries has indicated willingness to accept all PCB waste volumes from the project but they do not want to accept only a small quantity of highly concentrated waste. PCBs have been disposed of at the site in the past. The Illinois Environmental Protection Agency has indicated that obtaining a supplemental permit to dispose of PCBs at the BFI site would be the simplest option to pursue.

3. On-Site Engineering Evaluation

On October 10, 1980, the Browning-Ferris Industries site (BFI), located in Zion, Illinois, was inspected to assess the operational performance of the facility. The comments contained in the following sections are based on that site inspection and on a review of the existing plans prepared to date that have been submitted to the Illinois EPA.

a. Field Confirmation of Suitability

The main purpose of the field inspection was to assess present operational methods and site conditions to determine if they would be conducive to disposal of PCBs. Factors evaluated included the following; access control to the facility; monitoring of wastes that enter the facility; residential development around the landfill site; subsoil and groundwater characteristics; monitoring well locations; handling of surface water; control of dust; site construction and certification work; and overall operations and site monitoring. In general, based on the field inspection, this site appears to have potential for PCB disposal. However, as discussed later in this report, there are several areas that will need modification or improvement to allow disposal of PCBs.

b. Existing Engineering and Operational Features

This facility is designed to take municipal wastes and limited quantities of hazardous wastes. In the discussion of this facility, the existing site and proposed expansion site are considered as one site. It is known that certain modifications will be necessary to permit disposal of PCB contaminated material at this facility. Those modifications are discussed in the next section.

Base grades at the facility slope from Elevation 731 MSL in the west to Elevation 720 MSL in the east at approximately 1/2%. The base grades are designed so that a minimum of 10 feet of clay or till material exists above the sand lense that is present at depth in some areas of the facility, particularly in the expansion area. As areas of the site are excavated, shallow borings are performed to document the separation distance of 10 foot of clay or till material above any sand lense. The depth of excavation at the site to obtain base grades varies from 0 to 50 feet below existing ground throughout the facility. In general, the deeper excavations will be required in the expansion facility. The base grades are generally below the water table at the site.

The final grades reach a maximum height of 812' MSL in the central portion of the facility. From that crown, the final grades slope at approximately 5% in all directions. The sideslopes around the perimeter of the facility are designed at 5H:1V. The sideslopes tie into the perimeter core berm, which is constructed around the entire perimeter of the facility. This core berm is approximately 10 feet in height with 2:1 sideslopes and a 10 foot wide inner core of clay, and is constructed of clay with a permeability of 10^{-7} cm/sec, which does not meet IEPA regulations of 10^{-8} cm/sec. The maximum height to which final grades extend above existing g nd is approximately 80 feet at the crown. In most areas of the facility, .e final grades are 40 to 50 feet above existing ground. The final cover at this facility consists of 3 feet of on-site clay covered by 6 inches to 12 inches of topsoil.

This facility has no plans or provisions for leachate collection or removal.

The perimeter core berms serve to divert surface waters from entering the fill areas and apparently meet surface water diversion require-me s per USEPA regulations. Ditches are to be constructed, as necessary, a gside roadways and perimeter core berms to handle surface water. Surface water entering the fill area is routed to the low spot in the fill area and pumped to the ditches.

A well-constructed access road leads from the entrance of the facility to the fill areas. Roads within the fill areas are constructed of on-site materials and graded periodically to maintain trafficability. Slopes and layout of the roads are sufficient to permit access to and from the fill areas.

Drawing C 9400-3 indicates the sequence of filling operations. In general, filling has progressed from the north to the south. Present fill operations are occurring in the southeast corner of the existing site. Subsequently, operations will progress westward to the L-shaped section of the existing site. Fill operations in the expansion facility are to progress from north to south. In both areas, filling is accomplished by the area method. Cover materials are excavated from future fill areas, and utilized for daily cover with excess material stockpiled for use as final cover. As a condition of approval, the facility must maintain a 100 foot certified base grade section in advance of the working face. Base grade certification consists of a series of shallow soil borings (10 feet) to verify that clay or till is present to a 10 foot depth. Any coarse grained lenses encountered as a result of the borings are excavated and backfilled to attain the required separation distance.

The existing site has three monitoring wells located as shown on Drawing C 9400-3. In general, Monitoring Well #1 is located in the northeast corner of the existing facility, Montoring Well #2 is located in the southwest corner, and Monitoring Well #3 is located on the west central side of the site. As part of the construction of the expansion site, Monitoring Wells 4 through 7 will be added around the eastern and southern perimeters of that facility. According to well construction details, the wells apparently meet USEPA requirements. A water quality monitoring program does exist at this facility, but may require some modification to satisfy USEPA requirements regarding parameters for PCB disposal.

A short segment of gas venting trench is to be installed in the southeast portion of the facility. This gas venting trench is to be installed when any structures are completed within 500 feet of the filled area. In addition to the venting trench along the southeast corner of the facility, numerous gas vents are indicated on the proposed final layout of the filled area. The gas vents consist of a 4 inch diameter vent pipe surrounded by a 2 foot diameter gravel envelope installed approximately 20 feet below the final cover.

c. Modifications to Comply with PCB Disposal

The Illinois EPA and USEPA have several requirements regarding the construction and operation of disposal facilities for PCB materials. In addition, requirements are being drafted under the Resource Conservation and Recovery Act (RCRA) regulations that may alter the present regulations. Some of the present written regulations do not account for recent developments in landfill construction. Some of the indicated modifications for this facility go beyond the requirements of current regulations but are consistent with State of the Art practice. The following paragraphs discuss the modifications necessary to upgrade this facility to permit disposal of PCB materials. Two options (1A and 1B) are proposed for this facility, but, the following discussion is pertinent to both.

Option 1A consists of putting the waste partly above and partly below the ground (see Drawing C 9400-4), while Option 1B places the waste almost entirely below the ground (see Drawing C 9400-5). The options are located in different areas of the BFI site, and the difference in the engineering reflects the existing or proposed base grades for the respective locations of either Options 1A (existing site) or 1B (expansion site).

As indicated, Illinois EPA requires 10 feet of clay with a maximum permeability of 10^{-8} cm/sec below PCB disposal facilities. USEPA requires 3 to 4 feet of clay with a maximum permeability of 10^{-7} cm/sec beneath such a facility. The BFI facility is constructed over at least 10 feet of clay or till material. Additional testing will be necessary to document the permeability of the in-place clay at the site and its' recompaction characteristics, its' suitability for constructing a liner and/or using the clay in place in lieu of a liner. Based on available data, it appears that this material could be recompacted to comply with the 10^{-8} cm/sec permeability requirement. To comply with USEPA requirements, a liner system incorporating primary and underdrain leachate collection systems has been developed for this facility. This liner system is detailed on Drawings C 9400-4 (Option 1A) and 5 (Option 1B). The liner system consists of a 6 inch granular blanket which is covered by a filter cloth to minimize the infiltration of fine particles into the granular blanket. A perforated PVC pipe is installed within a granular backfilled trench below the granular blanket to collect and route leachate to a withdrawal point. The leachate collection lines lead to a series of manholes from which the leachate could be withdrawn. The leachate collection line is underlain by 4 1/2 feet of recompacted clay which, in turn, is successively underlain by an impermeable membrane, 6 inches of recompacted clay, and a 12 inch granular blanket, which would collect liquid material that penetrated the initial liners. This granular material leads to the underdrain leachate collection system. This underdrain leachate collection system is routed to another leachate collection withdrawal point. This underdrain system is underlain by a 2 foot recompacted clay liner. Beneath the 2 foot recompacted clay liner would be a minimum of 3 feet of existing clay or till.

This lining system and the leachate collection system are major modifications required at this facility. However, any facility designed to dispose of these wastes would have similar systems. Drawings C 9400-4 and 5 indicate the plan view layouts of the leachate collection systems.

Base grades slope toward the leachate collection lines at a minimum of 1%. Inward side slopes of the facility would be 2H:1V, constructed of recompacted clay to a thickness of five feet. The overall clay or till thickness on the sidewalls would be 10 feet with 5 feet of the thickness being in-place material.

The present surface water handling system for water outside the perimeter of the disposal facility is consistent with current requirements with regard to PCB disposal. However, any surface water that is in contact with the waste material should be treated as contaminated water and routed to the leachate collection systems. This is another modification required at this facility.

If PCBs were disposed of at this facility, a separate area would be constructed to separate them from other waste materials. In discussions with BFI personnel, they have indicated that they are willing to do this. Any PCB disposal area would be operated independently of other waste areas and promptly covered to minimize potential environmental damage.

The USEPA requires that groundwater be monitored from a minimum of three sample points on a routine basis. This facility complies with those requirements. However, based on a review of the hydrogeology of the facility and the locations of existing and proposed wells at the site, it also may be desirable to install additional wells to separate the effects of the existing facility on groundwater from the potential effects of PCB disposal.

The proposed gas venting system would be adequate, since limited gas is expected to be generated from the PCB disposal facility. The exact location of the PCB facility, when constructed, would dictate the gas venting requirements.

The final grades for the facility appear sufficiently sloped to minimize surface water infiltration into the site, thereby minimizing leachate production. A modification, which would further minimize infiltration through the surface of the landfill, would be the installation of an impermeable membrane in conjunction with the clay final cover. This impermeable membrane would be keyed into the impermeable membranes installed on the sideslopes and base grades.

In summary, the main modifications required at this facility would be the installation of a modified liner and leachate collection systems, and the modification of surface water handling practice. Leachate would require disposal either at a wastewater treatment facility or at an on-site treatment facility. In addition, contingency plans, operational plans, long-term care and monitoring plans would be required to address provisions to monitor the integrity of this facility for the future.

4. Transportation Methods

As mentioned earlier, the BFI disposal facility is located approximately 12 miles from the Waukegan Harbor area. The contaminated material might be transported via modified dump trucks. The dump trucks would be required to have a sealed tailgate with a flexible cover over the loads, with the boxes of the vehicles tight to prevent the leakage of contaminated material along the roadway. Thus, a main factor determining the transportation requirements of this material would be the water content and characteristics of the material to be transported. In any event, the vehicles utilized for transportation should be routinely inspected for compliance with the requirements.

The vehicles would be loaded using standard earthmoving equipment such as end loaders. Before the vehicles leave the loading area, they would be cleaned of any excess material not contained within the box, on the outside of the boxes and other parts of the trucks. The loading would be done in an area secured to minimize contamination from the loading operation.

The route utilized to transport the material to the disposal facility should be located to minimize exposure areas that have a high density of people.

5. Summary of Costs

We evaluated two different options for disposal of PCB material at the BFI facility; Option 1A consists of placing the material approximately 10 feet below existing ground and 20 feet above existing ground and would be located in the western portion of the existing facility. Option 1B involves placing the material below existing ground and would be located in a portion of the expansion area, as shown on Drawings C 9400-3, 4 and 5. The basic construction features, including the lining and leachate collection systems, would be the same for both options. The major factor that effects the cost difference between the two options is the additional excavation required of Option 1B (see Table 2). Otherwise, neither site has a significant cost or environmental advantage over the other.

The following cost summary has been divided into several categories. Those categories are; user costs, site preparation costs, operation and maintenance costs, site closure costs, and long-term costs. A detailed breakdown of this cost analysis is included in Appendix A for reference.

a. User Costs

User costs consist of the fees that would be charged by the owner/operator of the disposal facility to dispose of the waste at their facility. The Regional Director of Sales for BFI, George Edema, quoted transportation and disposal costs of PCB contaminated materials at the facility at $50 per cubic yard. This quote includes the required modifications to the facility, including installation of leachate collection system, a liner system, contingency plans, leachate collection and treatment costs, etc. The quote for transportation and disposal was based on a minimum disposal yardage of 200,000 cubic yards. The present estimated yardage requiring disposal is 367,000 cubic yards.

TABLE 1
USER COSTS FOR BFI SITE

Transportation Costs (assumed $10 per cubic yard)	$ 3,670,000
Disposal Costs	$14,680,000
Total User Costs	$18,350,000

b. Site Preparation Costs

Costs to construct a facility (Options 1A and 1B) to dispose of the PCB contaminated materials in compliance with current regulations were evaluated (see Appendix A). Costs are included for both options of disposal at the BFI facility. The factors included in the site preparation costs are as follows: excavation; placement of granular blanket and recompacted clay liners; installation of leachate collection system, underdrain system, filter cloth, and impermeable membrane liner; stripping topsoil; construction of drainage swale; and miscellaneous work.

TABLE 2
SITE PREPARATION COSTS - BFI

Option 1A	$1,365,000
Option 1B	$1,573,000

c. Operation and Maintenance Costs

Operation and maintenance costs are incurred in the day to day operation of the facility. Such costs include personnel, equipment operation and purchase, recordkeeping, water quality monitoring, and leachate collection and treatment. The operation and maintenance costs for both options is $350,000 per year. This is assuming that disposal of the wastes will be completed in one year.

d. Site Closure Costs

Site closure is the work associated with abandoning the facility when it has completed its operations. These costs include: the placement of final cover; seeding, fertilizing and mulching; placement of the PVC liner; installation of gas venting trenches; and miscellaneous work.

TABLE 3
SITE CLOSURE COSTS - BFI

Option 1A	$422,000
Option 1B	$424,000

e. Long-Term Care Costs

Long-term care includes the annual inspections and maintenance work necessary after the site has been abandoned to maintain its integrity and its function. Such costs include site inspections, site grading, seeding to replace eroded areas, leachate collection and treatment, water quality and gas monitoring, and recordkeeping. The costs for long-term care are the same for both options, which totals approximately $112,000.

f. Cost Summary

The following table summarizes the costs associated with the BFI facility.

TABLE 4
COST SUMMARY - BFI

	Option 1A	Option 2A
Site Preparation	$1,365,000	$1,573,000
Operational Costs	$ 350,000	$ 350,000
Site Closure	$ 422,000	$ 424,000
Long-Term Care	$ 112,000	$ 112,000
Total Cost	$2,249,000	$2,459,000

User Fee	
Transportation	$ 3,670,000
Disposal	$14,680,000
Total Cost	$18,350,000

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6. Summary - BFI Site

The BFI site has potential for disposal of PCB contaminated material. The physical/environmental and socio-economic characteristics of the site have been determined suitable for PCB disposal at the site, based on the findings of the preliminary screening assessment. The strongest points in favor of disposal at BFI are:

1. Favorable soils for site development.
2. Close proximity to the waste source.
3. Sparse population in the vicinity of the site.
4. Good transport access to the site.
5. The site management is willing to accept the waste.

Further, from an engineering viewpoint:

1. The facility appears suitable for modification with no special problems to comply with current regulations and standard disposal practice.
2. Disposal at the site is cost effective compared to disposal at the CECOS-Williamsburg, Ohio site, as discussed later.

Additional investigations that are required before further conclusions can be made regarding detailed engineering include:

1. Determining soil characteristics beneath proposed fill areas, specifically permeability as it relates to recompaction of the soils for liner construction.
2. Infield permeability testing of the soils to determine their use as in-place liner material.
3. Determining the existing groundwater characteristics of the site to develop the groundwater monitoring program, utilizing existing (and proposed) wells.
4. Further determining when, and what, quantities of PCB contaminated materials will be available, as well as determining the respective concentrations of PCB, such that a decision can be made as to what options at this facility might be most appropriately used.

B. CECOS (CER) - Williamsburg, Ohio Site - Option 2

1. Introduction

In the recommendations from our preliminary screening assessment at the various sites, we indicated that the CECOS site was conditionally recommended based on a comparison of costs for hauling the PCB contaminated dredge materials from the harbor area to the CECOS site as opposed to the development of closer sites, specifically the BFI site. This comparison is made below and it indicates that the cost of hauling the PCB contaminated dredge materials to the CECOS site is extremely costly. Furthermore, the cost for disposal of the contaminated sediments at the CECOS site is almost twice that of the disposal costs at the BFI site, based on disposal rates supplied by their respective site managers. Because of this situation and our recommendations, the level of detail concerning some of the information about the CECOS site, other than the summary of costs, is somewhat briefer than other disposal alternatives.

2. Environmental Characteristics

a. Site Hydrogeology

Topographic relief at the site is about 35 feet, with elevations ranging from about 879 feet MSL adjacent to Pleasant Run Creek (southwest) to about 913 feet MSL (northeast). Present and proposed disposal areas are located in a fairly flat area and meet USEPA requirements of low to moderate relief.

The general geology of the site is such that about 6 to 8 feet of a gray brown silty clay (CL) is underlain by about 40 feet of a gray-brown sandy clay till (SC, SC-SM), which in turn, is underlain by interbedded shale and limestone. In the western portion of the site, discontinuous sand seams are present about 25 feet to 30 feet below grade, however, in the eastern portion of the site, a continuous sand seam on the order of 5 feet thick that can be generally traced over a 20 acre area, where the new secured landfill cells are to be developed. The clay soils meet thickness requirements of USEPA (4 feet) and OEPA (25 feet).

Soil tests indicate that silty clay and clay till soils generally have permeabilities less than 1×10^{-7} cm/sec, meeting requirements of USEPA and conditionally meeting those of OEPA. Average properties of the surficial silty clay indicate: 70% P200, LL, 38% and PI, 20%, all meeting requirements of USEPA. Analysis of the clay till indicates: 30-50% P200, LL, 15-20% and PI, 5-7%. The P200 content meets USEPA requirements, however, the LL and PI do not. Permeability of the sand and gravel is approximated at 10^{-2} to 10^{-5} cm/sec, based on grain size analyses.

The interbedded limestone and shale bedrock lies approximately 50 feet to 60 feet below the ground surface. This rock formation yields little water, however, small quantities may percolate through fractures and in the weathered zone.

Depth to groundwater in the northern portion of the site is generally within 2 feet of the ground surface, while it varies from about 2 feet to 20 feet in the southern portion and from 2 feet to 7 feet in the western area; this does not meet the USEPA requirements of 50 feet to historical high water table below the base of the site or OEPA requirement of 5 feet below ground surface in certain areas.

Groundwater flows generally in a southerly direction toward the East Branch and southwestward toward Pleasant Run Creek, which are local discharge points. Vertical hydraulic gradients are generally slightly upward, however, are seasonally downward during recharge events, based on water levels from nested wells at the western and northeastern portions of the site. In the northern portion of the site, vertical hydraulic gradients are steeply downward in the vicinity of the pumped wells, in response to the pumping. Apparently, there is little hydraulic connection between the groundwater flow systems in the soils and in the underlying bedrock, however, there appears to be good hydraulic connection within the bedrock formation.

Apparently, six residences exist at the western boundary of the site which are on private water supply. Apparently, these residences are now owned by CECOS.

Pleasant Run Creek and its East Branch tributary generally flow in a southerly direction into the east fork of the Little Miami River. Pleasant Run Creek flows south through the property, just west of the secured landfill cells. The East Branch flows along the southeastern boundary of the site and joins Pleasant Run at the southwestern corner of the site. The site is not located within an established flood prone area, however, the streams exhibit flash-flood characteristics.

b. Socio-Economic Profile of the CECOS Site

The following section will briefly discuss disposal of the PCB waste at the CECOS site and the relationship of selected socio-political criteria to that option.

The CECOS Landfill site and vicinity is zoned agricultural. The rural setting is characterized by sparse farm and non-farm residents. Access to the site is via Aber Road, which is a very narrow local road. Transportation of the PCB wastes from the Waukegan area to the CECOS site would involve about 350 miles of travel. The most likely route from the Waukegan Harbor area to the landfill site would be I-294 south to Gary, Indiana, then southeast on I-65 to Indianapolis, then southeast on I-74 to I-275 in the Cincinnati area. Transportation over these interstate routes would not impact residential areas adversely.

Disposal of the PCB wastes at the CECOS site would not require hiring of additional personnel at the landfill although additions of employees would be required at the OMC site and Waukegan Harbor to excavate and remove the PCBs. It is not anticipated that any personnel would lose job positions which they currently hold as a result of disposal of the PCB wastes at the CECOS site.

Since the CECOS site is currently licensed to accept PCB wastes, no change in taxation or land use plans are anticipated. Exercising this disposal option will not add additional staff to the CECOS facility and there will be no change in existing disposal practices. Therefore, public support facilities such as schools, hospitals, police departments, fire departments, etc. will not be impacted.

The management of the CECOS site has indicated a willingness to accept all volumes of PCB waste generated in the clean-up operations. The site currently complies with the Federal Register 40 CFR 761 which allows them to receive 50 to 500 ppm PCB contaminated waste.

3. On-Site Engineering Evaluation

a. Existing Engineering and Operational Features

The CECOS-Williamsburg, Ohio facility is presently licensed to accept a wide variety of hazardous wastes, including PCB materials. A general layout of the facility is shown on Drawing C 9400-6. Since this facility is currently licensed to dispose of PCB materials, it has some of the modifications necessary to accept this hazardous waste as required by USEPA and Ohio EPA regulations.

The site is engineered with a multi-liner system, leachate withdrawal and monitor underdrain. The base of the landfill consists of 5 feet of recompacted clay overlain by an impermeable synthetic membrane liner, which is overlain by 2 feet of uncompacted clay as a protective layer. The membrane liner is also placed over 5 feet of recompacted clay till on the side slopes and ties into another membrane liner, which is placed over the waste as part of the final cover. Overlying the final cover membrane liner is 3 feet of clay material and 2 feet of final cover soil. Beneath the 5 foot clay liner is a 6 inch sand layer, which ties into the monitor underdrain system. The underdrain system serves as a secondary leachate collection system. The primary leachate collection system, which is installed on the base grades, consists of a perforated 24 inch diameter concrete standpipe into which leachate may flow. Leachate levels are not monitored or pumped on a routine basis, however, leachate is pumped from the cells on a periodic basis to maintain levels 2 feet below original grade. Presently, the leachate is pumped into a holding basin until a sufficient quantity is collected for treatment. The leachate treatment consists of pumping the leachate onto the top of the daily cover in an adjacent secured landfill cell, into which a chemical agent is added to solidify the leachate. The solidified leachate is then placed back into one of the secured landfill cells.

The design concept for disposal at the site is to develop individual secured landfill cells under dry disposal conditions. Within each cell, berms are used to separate incompatible waste types from each other.

Presently, the entire site is not fenced and access to the gate house and other site facilities is not controlled. However, each secured landfill site is fenced, which may meet USEPA requirements.

Because this site is a licensed facility, it is assumed that it complies with all USEPA and OEPA regulations regarding the daily operations and record keeping associated with PCB disposal. Daily site operations also include the visual inspection of individual loads as they come into the disposal site. However, only minimal laboratory tests are performed on the wastes to determine their chemical characteristics.

Traffic routing within the facilities is difficult for semi-trucks and other large trucks requiring access to the disposal areas. The modules are fairly small, and when they are divided into three different areas by the use of berms, there is little room for maneuverability for trucks to unload.

The facility has numerous monitoring wells (32) throughout the property. However, based on the actual location of the disposal facility, additional monitoring wells may be required to effectively monitor ground-water quality. The facility is monitored on a routine basis for water quality. The facility has gas venting systems for the secured landfill cells. In general, the facility complies with the regulations but would need limited upgrading to be in full compliance and to meet industry standards.

Surface water is diverted from entering cell areas per regulations for sites located above the flood plain. Surface water that falls into the cell areas is either treated as leachate or pumped to a surface water drainage system. The surface water in the cell areas is monitored for quality which determines the method of deposition of the surface water.

b. Modifications to Comply with PCB Disposal

Based on the site characteristics and design plans reviewed to date, some modifications are recommended to permit this facility to handle the PCB contaminated materials. The liner system would be modified to include a 6 inch granular blanket on top of the first 2 foot recompacted clay layer. This granular blanket would lead to a leachate collection system installed in the 2 foot clay material. This leachate collection system would replace the standpipe leachate collection system that presently exists at the site. Drawing C 9400-7 indicates a proposed detail of the liner system and a plan view of the location of the leachate collection system. The surface water handling system would be modified so any water in the cell area would be treated as leachate.

The underdrain system currently used would be modified so the granular material would be continuous underneath the site and the risers utilized to gain access to the underdrain system would be replaced with manholes.

This facility should have adequate contingency plans, operational and maintenance guidelines, etc. on file for the existing disposal operations. The main modifications would be the addition of a granular blanket to the lining system and the installation of a primary leachate collection system.

4. Summary of Costs

The following cost summary has been divided into several categories. Those categories are; user costs, site preparation costs, operation and maintenance costs, site closure costs, and long-term care costs. A detailed breakdown of this cost analysis is included in Appendix B for reference.

a. User Costs

The user cost is the fee that the operator of the facility would charge for disposing of the PCB contaminated material at his facility. Mr. Wayne Aldridge, Technical Director, CECOS, indicated their costs for disposal of this material would be $90 per cubic yard. In addition, they indicated their transportation costs for this material would be approximately $1300 per truckload from Waukegan to their disposal facility with each truckload hauling approximately 20 to 23 cubic yards of PCB contaminated materials. Therefore, the transportation costs for this material would be approximately $65 per cubic yard. Based on a volume of 367,000 cubic yards of PCB contaminated material, the disposal fee would be $33,030,000 and the transportation fee $23,855,000 for a total cost of $56,885,000.

b. Site Preparation Costs

The costs to construct a facility according to the proposed layout shown on Drawing C 9400-7 were evaluated (Appendix B). The following work elements were included in the site preparation costs for this facility; excavation, stripping topsoil, placement of recompacted clay liner, granular blankets, impermeable membrane liner, leachate collection system, underdrain system, drainage swales, filter cloth, and miscellaneous work. The estimated costs for this work is $1,162,000.

c. Operation and Maintenance Costs

Operation and maintenance costs are the costs incurred in the day to day operation of the facility. Factors included in this cost are; personnel, equipment, water quality monitoring, and leachate collection and treatment costs. The operation and maintenance cost is $350,000. This assumes the disposal operation would be completed within a one-year period.

d. Site Closure Costs

The site closure costs are the costs associated with abandoning the facility after it has reached its design capacity. Costs included in this are final cover placement, seeding, fertilizing and mulching, installation of impermeable membrane liner and gas venting system and miscellaneous. The estimated cost for this work is $323,000.

e. Long-Term Care Costs

Long-term care includes the maintenance and inspection of the facility after it has been abandoned to maintain its integrity and function. Work elements that need to be performed during that time would be site grading, seeding to repair erosion areas, water quality monitoring, gas monitoring, leachate collection and treatment, and record keeping. The cost for these activities is $112,000.

f. Cost Summary

The following table summarizes the costs associated with the CECOS facility.

TABLE 5
COST SUMMARY - CECOS

Element	Cost
Site Preparation	$ 1,162,000
Operational Costs	$ 350,000
Site Closure	$ 323,000
Long-Term Care	$ 112,000
Total Cost	$ 1,947,000
User Fee	
Transportation	$23,855,000
Disposal	$33,030,000
Total Cost	$56,885,000

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5. Summary - CECOS

As determined from the preliminary screening assessment of the alternative sites, this site is somewhat favorable for disposal because it is already licensed. Its' hydrogeological environment and engineering design were shown to be generally acceptable from our preliminary screening assessment. However, the site is highly unfavorable because of the extreme haul distance and associated costs. In addition, we have shown that the disposal fee at this site is roughly twice that of the closer, BFI site. Therefore, we do not recommend this site for disposal of the PCB materials, unless all other alternatives become unfeasible.

It has been shown that minor modifications to the existing engineering plan should be implemented, particularly upgrading of the leachate collection system. It is already a licensed site and apparently meets USEPA and OEPA requirements.

C. OMC Site

1. Introduction

Since the contamination problem considered in this report originates on the OMC property and nearby Waukegan Harbor, it is a necessary and reasonable to address the following:

1. Potential in-situ abatement alternatives to the contamination problem at the OMC property,

2. On-site disposal alternatives at the OMC site because of the proximity of the contamination to the OMC property and the high costs involved with off-site disposal of the PCB contaminated sediments, or

3. Combinations of 1 and 2, above.

Therefore, the following alternatives have been identified which could be implemented at the OMC property and are a part of this final evaluation process:

1. Option 3 - Total on-site excavation and disposal in parking lot.
2. Option 4 - Parking area disposal and slurry cutoff wall around crescent-shaped ditch and oval lagoon.
3. Option 5 - Coke plant storage lagoon, parking area disposal and slurry cutoff wall abatement.
4. Option 6 - Slurry cutoff wall in the north ditch area and lagoon storage for harbor dredge materials.
5. Option 7 - Disposal of all contaminated materials in lagoons at coke plant location.

These options are discussed below as individual alternatives, with cost estimates calculated for the development of each. The options are illustrated in Drawing C 9400-8 through C 9400-14.

Six very important points should be mentioned at the onset of this OMC discussion:

1. The particular alternatives that deal with in-situ treatment (as opposed to complete or temporary removal of the PCB contaminated soils) place the emphasis on correcting the problem at the site, and all the regulations regarding PCB disposal at landfill sites may not necessarily apply to the type of abatement procedures we have proposed in these alternatives. Nonetheless, we have attempted to be conservative in our conceptual approach to abatement of the PCB problem. Further, our engineering safeguards used in the abatement concepts are commensurate with those proposed by IEPA and USEPA for landfilling of PCBs.

2. Since the OMC site would be considered a new facility, it would have to go through the permitting processes with both State and Federal Agencies. This would create delays in implementing these options.

3. Any of the several options for OMC property would preclude the necessity of transporting the contaminated PCB material over the roadway to an off-site disposal facility.

4. IEPA has indicated that they do not favor permanent land disposal of PCB contaminated materials at the OMC site. They will more favorably consider temporary storage for ultimate removal. The decision whether PCB disposal will be allowed at the OMC site on a permanent basis is an issue that will have to be reached at the State-Federal level. In addition, public reaction to on-site alternatives is unpredictable.

5. All the on-site options will require additional hydrogeologic investigation to better define soil and groundwater conditions to assess the suitability of potential on-site alternatives. Until this work is done, it is difficult to speculate on what additional engineering details might be needed for development of any of the on-site options.

6. For any on-site disposal option, a clay borrow search should be conducted to identify potential sources of clay liner and capping materials.

Items 1 and 2 above point to potential delays in the permitting process, especially if it involves breaking new ground concerning the abatement alternatives and how the landfilling rules might apply to abatement (as opposed to disposal). Items 3 and 4 pose the respective best and worst conditions for on-site disposal. IEPA could cause considerable problems in implementing permanent on-site alternatives if they choose to. In contrast, any on-site alternative is cost effective, compared to off-site disposal.

2. Environmental Characteristics

a. Regional Setting

The OMC property is located in portions of the SW 1/4 and SE 1/4, Section 15 and the NW 1/4, Section 22, T45N, R23E, Lake County, Illinois. This site is bounded on the East by Lake Michigan, on the south by Waukegan Harbor on the west by the Chicago and Northwestern Railroad tracks and on the north by the North Shore Sanitary District Property.

The topography in the vicinity of the OMC property varies from flat to gently rolling. Elevations range from about 660 feet MSL two miles west of the OMC property to about 580 feet MSL at the edge of Lake Michigan.

Geologically, the low terrace level around Lake Michigan consists of recent shore deposits consisting of a variety of beach and beach related (dune and near shore marsh) deposits. Underlying the beach deposits at the site and to the west where the beach deposits thin out, lies a clayey silt glacial till. The thickness of this till unit is estimated at about 150 feet and includes a basal sand and gravel layer that overlies bedrock. Bedrock in the vicinity of this site is Silurian dolomite.

Groundwater is generally expected to occur within 5 to 35 feet of ground surface, and generally flows east toward Lake Michigan, or more locally, toward the Waukegan River. The Waukegan River drains into Lake Michigan approximately one mile south of the OMC property.

b. Site Hydrogeology

Topographically the site is located in a flat area adjacent to Lake Michigan. Elevations on the property range from about 582 feet MSL on the shore of Lake Michigan to about 586 feet MSL at the western margin of the property. This low relief meets USEPA requirements for PCB waste disposal.

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The general geology of the area is such that 0 to 8 feet of sandy fill material (gray brown, fine to coarse, trace to little gravel, trace to little silt and clay; SP, SM, SP-SM, SP-SW) overlies sand (gray to gray brown, fine to coarse, trace to some gravel, trace to little silt and clay; SP, SP-SM, SM) to a depth of about 28 to 30 feet below ground surface. The sand layer, in turn, is underlain by a silt (gray to gray brown, some clay, trace sand, trace gravel; ML, ML-CL), which apparently is a glacial till deposit. This silty till deposit is underlain by dolomite bedrock about 150 feet below ground surface. The surficial sandy soils do not meet the USEPA and IEPA soil requirements for the development of PCB waste disposal. Therefore, a suitable liner would have to be constructed on-site to facilitate the disposal of PCB contaminated sediments at this site.

Soil tests indicate that the sandy soils have permeabilities ranging from about 8 x 10^{-4} to at least 8 x 10^{-3} cm/sec, based on infield baildown permeability tests performed on monitoring wells screened in the sandy soils. These sandy soils typically have less than 12% P200 content. The underlying silty layer has a permeability of about 1 x 10^{-7} cm/sec, based on one laboratory tested sample. LL and PI are typically less than 21% and 5%, respectively, while P200 content is typically 95% to 100%.

Depth to groundwater at the site is typically less than 5 feet below ground surface. This does not meet USEPA requirements of 50 feet to historical highwater table below the base of the site. Groundwater flow on the site varies from north (toward the north drainage ditch) to east toward Lake Michigan, which are both groundwater discharge points for the shallow groundwater system in the surficial sands. Groundwater is recharged into this shallow groundwater system directly through the permeable sands on the property. Typically, the vertical hydraulic gradients near the north ditch are upward, indicating groundwater discharge conditions there. However, when the water level in the ditch is sufficiently high, such as caused by the backing up of water in the ditch by an on shore wind, groundwater recharge conditions may occur in the upper portions of the groundwater system. This site may not meet USEPA requirements as it lies in a zone of groundwater recharge and because of its proximity to the Lake Michigan shoreline.

Surface water bodies on-site include the north ditch and associated lagoons at the western end of the ditch system. These lagoons and the north ditch are a major source of PCB contamination at the site. The north ditch is hydraulically connected to Lake Michigan.

c. Socio-Economic Profile for the OMC Site

The following section will briefly discuss disposal of the PCB waste at the OMC site and the relationship of selected social political criteria to that option.

Land use surrounding the OMC site is predominantly industrial. Lake Michigan borders the site on the east, with the Chicago, Northwestern Railway Lines forming the western border of the site. Approximately 1/2 mile west of the site, the urbanized area of the City of Waukegan begins.

There is no residential population in the immediate site vicinity due to its industrial nature. The City of Waukegan urbanized area is densely populated and is isolated from the site via the Chicago and Northwestern Railroad line and Sheridan Avenue.

Transportation routes from the site radiate in a north, west and south direction. No transportation routes exist to the east because of the presence of Lake Michigan. The OMC site has ready access from the Waukegan Harbor area along Seahorse Drive, which terminates at the gatehouse of the OMC property closest to Lake Michigan.

Employment opportunities may be increased due to the OMC PCB clean-up. This increase would be temporary and involve only those workers specifically involved in the clean-up procedures. It is not expected that any existing employees would lose their jobs in relationship to the on-site PCB disposal. Disposal of the PCB wastes would not generate additional revenue and should not change the tax rate of the site. On-site disposal would not create a burden on existing public facilities such as schools, hospitals, police protection, fire protection, etc. However, on-site disposal would disturb much of the parking area at the OMC property to ranging degrees, depending on which disposal option was implemented, if any.

It is not expected that surrounding land use change would occur as a result of on-site disposal. The existing site use would remain industrial and the residential area to the west would remain unchanged.

It is not presently known whether OMC management would welcome the development of permanent waste disposal areas on their property, however, it may be economically attractive, depending on the extent of their financial liability (we will show that on-site alternatives are considerably less costly that off-site disposal). However, Illinois EPA has indicated that they believe that long-term disposal of PCB waste at the OMC property is not a favorable condition.

3. Option 3 - Total On-Site Excavation and Disposal in Parking Lot

a. Introduction

This option consists of disposing of all the PCB contaminated materials in the parking lot area north of the OMC buildings, as presented on Drawing C 9400-8. Material from both the harbor area, and the north ditch and parking areas would be disposed of in this facility. The material from the harbor area would first be dewatered in temporary lagoons located on the old coke plant site.

b. Engineering Features

The facility would occupy the majority of the parking area presently located north of the OMC buildings with dimensions of 1700 feet long and 330 feet wide. This facility would be constructed so it is in compliance or commensurate with existing Illinois EPA and USEPA requirements for PCB disposal.

To facilitate construction of this facility, a slurry cut-off wall would be constructed around the perimeter of the facility to allow dewatering of the disposal site. This slurry cut-off wall system would be tied into the underlying silt layer at approximately 30 feet below the surface. This area could then be dewatered internally, which would permit the construction of the facility utilizing standard construction procedures. The water removed from this area must be treated since it may be contaminated with PCB. The contaminated soils excavated during the construction of the site (slurry cutoff and excavation of base grades) may have to be temporarily stockpiled, (in temporary storage lagoons, if built first), while an initial phase or module of the disposal area could be readied for use. Otherwise, the material could be delivered to a site licensed for

PCB disposal, but this could raise the costs of this option significantly. As newly contaminated material is excavated, it can be transferred to the completed portion of the fill area. Those sediments excavated which are not contaminated with PCB could be taken away and dumped as fill. Slurry cut-off walls utilized in this and other options for the OMC site would be approximately 2 1/2 feet in width and would be tied into the underlying silt layer, approximately 25 to 30 feet below the surface. The width of the cutoff is controlled by the type of equipment and can usually be varied within 1 1/2 feet to 3 feet. The slurry wall trenches would be backfilled with an impermeable bentonite/clay mixture. Bentonite slurry walls typically exhibit permeabilities in the range of 10^{-7} to 10^{-8} cm/sec. Existing utilities or abandoned utilities throughout this proposed disposal area would be relocated or removed.

Base grades of the facility would be approximately 30 feet below existing ground. Below grade, the liner and leachate collection systems would be installed (see Drawing C 9400-8). This liner system consists of a 6 inch granular blanket covered with a filter cloth to minimize infiltration of fine grained particles into the granular blanket. Below the granular blanket a 5 foot recompacted clay liner would be placed. All clay for this liner system would have to be imported to the site and would be recompacted to meet 10^{-8} cm/sec permeability requirements. A leachate collection line would be installed in the 5 foot clay liner, which would lead to manholes for leachate removal. An impermeable membrane liner would be installed in the lower portion of the 5 foot recompacted clay liner, which would be successively underlain by a 12 inch granular blanket which leads to the underdrain system, a 2 foot recompacted clay liner, and the existing silt material, which has a permeability of approximately 10^{-7} cm/sec. The underdrain system would lead to manholes for leachate removal. The layouts of the leachate collection system and underdrain system are shown on Drawing C 9400-8.

Base grades would slope toward the leachate collection system at a minimum of 1%. The sidewalls would be constructed of 10 feet of recompacted clay with an impermeable membrane liner installed in the clay. Sideslopes at the facility would be at a 3H:1V slope.

Though the facility would be constructed below the existing groundwater level, groundwater infiltration through the slurry cut-off wall and liner system into the the wastes would be minimal. By maintaining an inward gradient, the potential for contaminant migration is lessened. The facility would be maintained as a dry system with any leachate removed from the site and disposed of at a treatment plant facility either on-site or off-site.

Groundwater monitoring wells would be installed around the facility to ascertain background water quality and monitor liner effectiveness. As indicated earlier, a minimum of three wells is required by USEPA. However, more wells should probably be installed to adequately monitor the facility.

The final cover of the facility would permit the return of the area to parking use. The final cover would consist of 12 inches of clay, an impermeable clay membrane liner, and an additional 2 feet of clay. The clay would be covered with gravel bituminous pavement. This final cover design is conceptual and a proper final design should consider the best method to minimize potential cracking of the bituminous and underlying clay cover soils. The bituminous pavement would minimize maintenance to the final surface by limiting soil erosion and vegetation maintenance. By utilizing this final cover, water infiltration should be limited to the practical minimum. The impermeable membrane liner in the final cover would be tied to the impermeable membrane liner along the sides and on the base of the facility.

c. Summary of Costs

The following cost summary has been divided into several categories. Those categories are site preparation costs, operation and maintenance costs, site closure costs and long-term care costs. A detailed breakdown of this cost analysis is included in Appendix C for reference.

(1) Site Preparation Costs

Site preparation costs are incurred in developing the facility for acceptance of PCB contaminated wastes. Factors included are the following: excavation; slurry cut-off wall construction; clay liner construction; placement of granular blankets, filter cloth and impermeable membrane liner; recompaction of existing silts; leachate collection and underdrain system installation; disposal of excavated materials; relocation of utilities; and miscellaneous work. The site preparation cost for this option is estimated to be $5,852,000. This does not include any funding to restore areas that were excavated to remove PCB materials to their original grade.

(2) Operational Costs

Operational costs are incurred during the disposal of the PCB contaminated material. Work elements include the following: personnel, equipment, record keeping, water quality monitoring, and leachate collection and treatment. The cost for this work is estimated to be $350,000, assuming that the work is completed in one year.

(3) Site Closure Costs

Site closure costs are those costs occurred in abandoning the facility after the completion of the disposal of the PCB contaminated materials. Cost factors included are clay cover placement, impermeable membrane liner installation, gas venting installation, subbase and bituminous pavement construction, and miscellaneous work. The costs for abandoning this facility is estimated to be $1,463,000.

(4) Long-Term Care Costs

Long-term care costs are the costs incurred to maintain and inspect the facility after it has been abandoned. These costs include the following work elements; site inspections, final grade maintenance, water quality and gas monitoring, leachate collection and treatment, and record-keeping. These costs total about $112,000.

(5) Cost Summary

The following table summarizes the costs for this option.

TABLE 6
COST SUMMARY - OPTION 3

Site Preparation	$5,852,000
Operation	$ 350,000
Site Closure	$1,463,000
Long-Term Care	$ 112,000
Total	$7,777,000

d. Summary - Option 3

This option is the construction of a secured landfill in the parking area on the northern edge of the OMC property. The option would utilize the construction of a recompacted clay liner. A leachate collection system and back-up underdrain system would be installed. The facility would be surrounded by a bentonite slurry cut-off wall keyed into the underlying silt layer for added security and allow dewatering of the disposal facility. This option requires long-term maintenance on the part of OMC or EPA, which includes leachate collection and treatment.

The favorable aspects of this on-site disposal option include:

1. Minimal handling of the PCB materials, compared to off-site disposal options, which significantly minimize costs.
2. Encapsulization of the wastes in an area that already is affected by PCB contamination.
3. Adequate environmental protection with leachate collection clay liners, slurry cutoff wall, etc.

Unfavorable aspects of this option include:

1. Maximum on-site handling of PCB materials compared to other on-site options.
2. Extensive dewatering during construction.
3. IEPA's unfavorable opinion of any permanent on-site disposal option.
4. Potential stockpiling of PCB contaminated materials until a module of the disposal area is ready for use, or disposal at a licensed site.
5. Disruption of OMC's parking facility for a considerable length of time.

This facility has limited documentation of existing hydrogeology and would require feasibility studies before detailed engineering plans could be completed. This may create delays in the timetable for actual disposal of material. In addition, approval would be needed from OMC to utilize their parking area and to close it for the duration of the disposal project.

4. Option 4 - Parking Area Disposal and Slurry Cutoff Wall around Crescent-Shaped Ditch and Oval Lagoon

a. Introduction

This option utilizes a combination of slurry cutoff wall containment and secured landfill disposal. The materials in the crescent-shaped ditch and the oval lagoon would remain in place with a slurry cutoff wall constructed around the perimeter of the areas. The other PCB contaminated materials from the north ditch area and the dredge materials from the harbor would be placed in the parking area, as discussed in Option 3.

Based on preliminary information on the location, concentration, and depth of PCB contamination, it appears that the areas of deepest PCB contamination are the crescent-shaped ditch and oval lagoon. Therefore, this system was designed to allow those contaminated sediments to remain in place while removing the more shallow contaminated materials in the ditch area.

b. Engineering Features

The disposal facility located in the parking area would be constructed as indicated in Option 3. For reference, details of the liner and final cover are included on Drawing C 9400-9. In general, the liner consists of two layers of recompacted clay along with an impermeable membrane liner. There is a primary leachate collection system and a leachate collection underdrain system. The final cover consists of 3 feet of clay, an impermeable membrane liner, and bituminous pavement to reduce the area back to parking use. Drawing C9400-9 also indicates the layout of the leachate collection and the underdrain systems. The parking area disposal facility would require collection and treatment of the leachate to maintain a dry base site. Bentonite slurry cutoff walls would be installed around the perimeter of the disposal facility to permit construction by standard techniques.

Any utilities that exist in the construction area, including those that are in the vicinity of the crescent-shaped ditch, oval lagoon and parking lot disposal facility area, must be relocated. The materials from the dredged harbor area would be dewatered in lagoons at the old coke plant site, similar as proposed in Option 3. Similarly, contaminated materials collected during excavation of the parking lot disposal area and the proposed slurry cutoff trenches could be temporarily stored in the temporary storage lagoons, provided they are built first.

A slurry cutoff wall would be constructed around the crescent-shaped ditch and the oval lagoon. This slurry cutoff wall would be approximately 2 1/2 feet wide and constructed to a depth of about 25 to 30 feet to key into the existing silt layer underlying the site. Bentonite slurry walls typically exhibit permeabilities in the range of 10^{-7} to 10^{-8} cm/sec. As the slurry cutoff wall trench is excavated with a backhoe a bentonite slurry is added to form the trench and a seal on the inside and outside of the trench. The seal stops the flow of water into the area and, conversely, stops the migration of contaminants out of the area. A bentonite/clay mixture is then placed into the trench to bring the trench to original grade. The slurry cutoff wall construction technique is commonly used in construction to provide an impermeable barrier to groundwater flow so areas can be dewatered.

A leachate collection system would be installed in this area to maintain an inward gradient, however, only those soils needing removal to facilitate the installation of the collection system would be excavated from the area, which would subsequently be temporarily stockpiled until a permanent disposal area was ready. The leachate collection system would be installed approximately four feet below existing groundwater and a leachate maintenance level would be established at approximately 2 to 4 feet below groundwater to maintain inward gradients.

An important element of this system is the in-place permeability of the underlying silt, which will require documentation. Based on information to date, it appears that the underlying silt is about 150 feet thick and exhibits a permeability of 10^{-7} cm/sec.

An extensive groundwater monitoring system would be installed to monitor the effectiveness of the engineering modifications on the basis of water quality.

c. Summary of Costs

The following cost summary has been divided into several categories. Those categories are: site preparation costs, operation and maintenance costs, site closure costs, and long-term costs. A detailed breakdown of this cost analysis is included in Appendix D.

(1) Site Preparation Costs

Site preparation costs are costs incurred in development of a disposal facility. The following work elements are included in site preparation costs for this option: excavation; placement of clay liner, filter cloth, granular material, and impermeable membrane; installation of leachate collection and underdrain systems; placement of slurry trench for dewatering; placement of slurry trench for containment; disposal of excavated materials; relocation of utilities, and miscellaneous work. The site preparation costs for this option are $5,973,000.

(2) Operation and Maintenance Costs

Operation and maintenance costs are the costs incurred in the day to day operation of the facility. Such costs include personnel, equipment, record keeping, water quality monitoring, and leachate collection and treatment. The cost for this option is about $350,000 per year. This is assuming that disposal of the wastes will be completed in one year.

(3) Site Closure Costs

Site closure costs are the costs to abandon the disposal facility and to place a cap over the in-situ containment facility to protect the underlying contaminated materials and to minimize surface water infiltration. The following work elements are included in the site closure costs for this option: placement of final cover and impermeable membrane liner; installation of bituminous pavement including base course; seeding, fertilizing and mulching; installation of gas vents; and miscellaneous work. The site closure costs for this option is $1,544,000.

(4) Long-Term Care Costs

Long-term care includes the annual inspections and maintenance work necessary after the site has been abandoned to maintain its integrity and its function. Such costs include site inspections, site grading, seeding to replace eroded areas, leachate collection and treatment, water quality and gas monitoring and record keeping. The costs for long-term care is approximately $112,000.

(5) Cost Summary

The following table summarizes the cost for Option 4 of handling the PCB contaminated disposal of waste at this location.

TABLE 7
Cost Summary - Option 4

WORK ELEMENT		COST
Site Preparation		$5,973,000
Operational Costs		350,000
Site Closure		1,544,000
Long-Term Care		112,000
	TOTAL COSTS	$7,979,000

d. Summary - Option 4

The favorable aspects of this option are generally similar to those of Option 3 (with the exception of the amount of contaminated materials handled on-site), and further, its' cost is comparable to Option 3's. Similarly, the drawbacks associated with Option 3 also generally apply to Option 4, however, an additional circumstance can be identified. In the area of the crescentshaped ditch and oval lagoon, there is risk involved with the the long-term reliability of the slurry cutoff. Failure of the wall could result in excess leachate handling from the area, and perhaps, further groundwater contamination from leachate leaving the contained area. The performance of the system could be monitored by a thorough groundwater monitoring program.

As with all on-site options, subsurface investigations would be required to evaluate the hydrogeologic conditions and its' suitability with respect to the use of this option.

5. Option 5 - Coke Plant Storage Lagoon, Parking Area Disposal and Slurry Cutoff Wall Abatement

a. Introduction

This option utilizes three different disposal areas to handle the PCB contamination problem. This option also presents two methods to handle the wastes in the crescent-shaped ditch and the oval lagoon areas. In Option 5A, the materials in the crescent-shaped ditch and oval lagoon would be surrounded by a slurry cutoff wall and left in place. In Option 5B, the materials in the crescent-shaped ditch and oval lagoon would be placed in the parking lot disposal facility. The remaining materials in the north ditch area would be placed in a disposal facility located in the parking lot. The materials from the harbor dredgings would be placed in lagoons located on the coke plant site. These lagoons would be constructed to permit long-term disposal rather than temporary storage. These disposal options are presented on Drawings C 9400-10 and 11.

b. Engineering Features

(1) North Ditch Area

For Option 5A, the slurry cutoff wall system around the crescent-shaped ditch and oval lagoon would be the same as utilized and discussed in Option 4. Any utilities traversing that area would be removed and rerouted.

For Option 5A, the other contaminated materials located in this north ditch area would be excavated and disposed of in the disposal facility indicated on Drawing C 9400-10. Uncontaminated soils excavated from this area would be used in the construction of the storage lagoons at the coke plant site. This facility would be approximately 880 feet long and 330 feet wide. The depth and width of the disposal area may be modified depending upon the actual depth of the underlying silty layer. If the silt layer is within 25 feet of the surface and exhibits an adequate permeability (10^{-7} to 10^{-8} cm/sec), the liner system could probably be tied into the silt layer as has been proposed in Options 3 and 4. However, if the silt layer is at a depth greater than approximately 35 feet, then additional clay materials would be imported to the site for use as liner rather than tying the liner into the existing silt layer. For the economic analysis, it was assumed that clay would be imported.

The liner system for the north ditch area in Option 5A would consist of two 5 foot recompacted clay layers. On top of the first 5 foot recompacted layer would be a six inch granular blanket which would be covered by a filter cloth, while an impermeable membrane liner would be installed at the base. Underlying the first 5 foot clay liner would be a 12 inch granular blanket, which would lead to the underdrain system, underlain by a second 5 foot recompacted clay liner. The final cover to be utilized for Option 5A would be the same as that utilized for Option 4.

For Option 5B, the crescent-shaped ditch and oval lagoon contaminated materials, as well as the other contaminated materials in the north ditch, would be diposed of in the parking lot disposal facility indicated on Drawing C 9400-11. This facility would be approximately 806 feet long and 330 feet wide. The liner system utilized for Option 5B would be the same as utilized in Options 3 and 4. The detail of the liner is also shown on Drawing C 9400-11.

Both options in the parking lot disposal area would contain leachate collection and underdrain systems, as indicated in previous options. The base grades would slope at 1% toward the leachate collection system.

The slurry cutoff wall system would be utilized around the disposal facility in the parking lot to dewater the area to permit construction by standard techniques. Any utilities located in these areas would have to be relocated as in past options. The parking area would be returned to parking use after its abandonment.

(2) Harbor Material

The permanent storage lagoons for the harbor dredgings (Options 5A or 5B) lagoons would be constructed at the location where the temporary dewatering lagoons were constructed for other options. These lagoons would serve as dewatering lagoons as well as the final disposal location for the material from the harbor. The layout of the lagoons and associated details of the lagoons are shown on Drawings C 9400-10 and 11. The lagoons would be constructed above ground since the coke plant site has numerous foundations underground and residue presently located there that would make excavation difficult. The maximum height of the lagoons above existing ground would be approximately 30 feet. The interior of the berms would be lined with 10 feet of recompacted clay. In addition, an impermeable membrane liner would extend up those side slopes and tie into the final cover impermeable membrane liner.

The base grade liner system would consist of a 6 inch granular blanket on top which is covered with a filter cloth. A 5 foot clay liner would be placed below the granular blanket with a membrane liner. Installed near the bottom of the clay liner would be an impermeable membrane liner. The leachate collection system would be installed in the top of the clay liner. Underlying the first clay liner would be a 12 inch granular blanket which would drain to the underdrain system. A leachate collection underdrain system would be installed below the 12 inch granular blanket which would route the leachate into manholes for disposal. Underlying the granular blanket would be another 5 foot recompacted clay liner. The liner system would consist of a total of 10 feet of clay and an impermeable membrane liner. The lagoons would also have primary and underdrain leachate collection systems to collect and route leachate for disposal.

The lagoons would be maintained as dry bottom sites and any leachate produced or collected in the leachate collection system would be treated. No slurry cutoff walls or relocation of utilities would be needed in the storage lagoon area.

Monitoring wells would be installed around the lagoons to monitor the effectiveness of the leachate collection systems and the liner. Since this facility would be constructed above ground, any migration of leachate would probably yield a discharge to the surface surrounding the lagoons. This requires that the lagoons be inspected frequently to detect for seepage from them.

The final cover for the lagoons would be the same as the parking lot areas except the lagoon would receive topsoil and be seeded, fertilized and mulched rather than paved with bituminous. With the placement of the impermeable membrane liner and the final cover, surface water infiltration is drastically reduced.

c. Summary of Costs

The following cost summary has been divided into several categories. Those categories are site preparation costs, operation and maintenance costs, site closure costs and long-term care costs. A detailed breakdown of this cost analysis is included in Appendix E for reference.

(1) Site Preparation Costs

Site preparation costs are those costs incurred in the development of the disposal facilities. For Option 5A those costs would include the following items: placement of clay liners, filter cloth, and granular blankets; installation of impermeable membrane; installation of leachate collection and underdrain systems; placement of slurry trench for dewatering and containment; relocation of utilities; construction of lagoon berms; construction of drainage swale; and, miscellaneous work. Option 5B would include the same costs as Option 5A except for the slurry trench cost for containment of materials in the crescent shaped ditch and oval lagoon areas.

TABLE 5
Site Preparation Costs - Option 5

	NORTH AREA MATERIAL	HARBOR MATERIAL	TOTAL
Option 5A	$3,481,000	$5,204,000	$8,685,000
Option 5B	$2,070,000	$5,204,000	$7,274,000

(2) Operation and Maintenance Costs

Operation and maintenance costs are the costs incurred during the placement of the contaminated materials in the disposal facilities. These costs include: personnel, equipment, record keeping, leachate collection and treatment, groundwater quality monitoring, etc. The costs for both Options 5A and 5B are $130,000 for the north area facility and $227,000 for the lagoon area.

(3) Site Closure Costs

Site closure costs are the costs incurred to abandon the disposal facilities when disposal operations have ceased. Work elements included are: placement of final cover, installation of bituminous pavement, impermeable membrane liner, and gas venting system, seeding, fertilizing and mulching; and miscellaneous work.

TABLE 9
Site Closure Costs - Option 5

	NORTH AREA MATERIAL	HARBOR MATERIAL	TOTAL
Option 5A	$848,000	$1,163,000	$2,007,000
Option 5B	$660,000	$1,163,000	$1,823,000

(4) Long-Term Care Costs

Long-term care costs are the costs to inspect and maintain a facility after its abandonment. Costs included in this option are: site inspections, site maintenance, (including grading, seeding, etc.), water quality and gas monitoring, leachate collection and treatment, and record-keeping. The costs for long-term care for the north area is $66,000 and for the harbor area is $66,000 for both options.

(5) Cost Summary

The following table summarizes the cost for Option 5.

TABLE 10
Cost Summary - Option 5A

COSTS	NORTH AREA	HARBOR MATERIAL	TOTAL
Site Preparation	$3,481,000	$5,204,000	$ 8,685,000
Operation and Maintenance	$ 130,000	$ 227,000	$ 357,000
Site Closure	$ 848,000	$1,163,000	$ 2,011,000
Long-Term Care	$ 66,000	$ 66,000	$ 132,000
TOTAL	$4,525,000	$6,660,000	$11,185,000

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TABLE 11
Cost Summary - Option 5B

COSTS	NORTH AREA	HARBOR MATERIAL	TOTAL
Site Preparation	$2,070,000	$5,204,000	$7,274,000
Operation and Maintenance	$ 130,000	$ 227,000	$ 357,000
Site Closure	$ 660,000	$1,163,000	$1,823,000
Long-Term Care	$ 66,000	$ 66,000	$ 132,000
TOTAL	$2,926,000	$6,660,000	$9,586,000

d. Summary - Option 5

Options 5A and 5B are somewhat similar in scope, except that Option 5A is more costly because of the site preparation cost involved with three disposal facilities (Option 5A) as opposed to two (Option 5B). Compared to Options 3 and 4, Options 5A and 5B are more costly because of the development of permanent storage lagoon facilities.

Favorable aspects of Options 5A and 5B include:

1. Minimum haul distances for disposing contaminated materials on-site.
2. Less intense development of disposal facilities in the OMC parking area, as only half the area will be a disposal area.
3. Minimal disruption of the oval lagoon and crescent-shaped ditch area (Option 5A).
4. Minimal leachate handling in the dry base storage lagoons which are constructed above ground.

Unfavorable characteristics of Options 5A and 5B are generally similar to those in Options 3 and 4; however, also include:

1. Design, development and maintenance of of multiple disposal and abatement facilities, especially, Option 5A.

2. Acquiring the use of the coke plant - OMC property for permanent disposal, as opposed to use as a temporary dewatering facility in Options 3 and 4.

3. The permanent storage of the material in an above ground facility is relatively unsightly, creates difficulties in maintaining the raised surface (as opposed to a flat surface) and, in addition, above ground storage severely limits potential end use of the land.

6. Option 6 - Slurry Cutoff Wall in the North Ditch Area and Lagoon Storage for Harbor Dredge Materials

a. Introduction

This option consists of constructing a slurry cutoff wall around the entire contaminated area in the north ditch area and disposing of the harbor dredge materials in permanent storage lagoons at the coke plant site. This requires no excavation of materials in the north ditch area and would create minimal disruption to the existing operations of OMC in that vicinity.

b. Engineering Features

The storage lagoons for the harbor dredge materials would be the same as utilized for Option 5. The liner systems, leachate collection systems, final cover systems, etc., would be the same and a discussion of them will not be repeated in this section. However, all earth materials used in the construction of the storage lagoons would be imported from off-site, as opposed to Option 5, which would partially utilize on-site materials excavated from the parking lot area.

Compared to the previously discussed options, this option maximizes abatement in the north ditch area. This option would construct a slurry cutoff wall around the perimeter of the north contaminated area and leave the contaminated materials in place. A general location of the cutoff wall is indicated on Drawing C 9400-12. The cutoff wall would be excavated five feet into the underlying silt material and tied into that layer. An important factor in this option is the permeability and depth of the underlying silt layer. The construction procedures, and reliability of the bentonite slurry cutoff wall have been discussed before, and also apply to this option. Any utilities that cross the slurry cutoff wall would have to be removed and relocated.

A leachate collection system would be installed as indicated on Drawing C 9400-12. This leachate collection system would be installed approximately 4 feet below groundwater and would be utilized to maintain an inward gradient toward the containment facility. This would minimize the chance for migration of contaminated liquid out of the containment area through the slurry walls. The maintenance of an inward gradient requires monitoring of the groundwater level around the vicinity and the leachate level within the facility so the leachate level in the containment area is always lower than the groundwater. Leachate collected from this facility would have to be treated. Extensive groundwater monitoring wells would be installed to document the integrity of the slurry cutoff wall.

The area would probably be covered with clay materials and paved with bituminous paving as indicated in detail on Drawing C 9400-12. This method would create little disruption to OMC operations and their parking lot compared to other options.

If funding is limited at this time, it may be feasible to construct this slurry cutoff wall system to contain the waste in its present locations and limit further migration of the wastes. When additional funding is available, the materials could be excavated and placed in a secure disposal facility as discussed in previous options.

This adds minimal cost to the project since slurry cutoff walls probably would be required for dewatering to permit excavation of the contaminated materials.

c. Summary of Costs

The following cost summary has been divided into several categories. Those categories are site preparation, operation and maintenance costs, site closure costs, and long-term care costs. A detailed breakdown of this cost analysis is included in Appendix F for reference.

(1) Site Preparation Costs

Site preparation costs are the costs incurred in developing a facility for disposal of wastes. The factors included in the site preparation costs are as follows: placement of granular blanket and recompacted clay liner, installation of leachate collection system, underdrain system; filter cloth, and impermeable membrane liner, construction of drainage swales, etc., and miscellaneous work.

All the costs associated with the construction of the slurry cutoff wall and the containment of material in the northern area are covered in the Site Closure Costs. Site preparation costs for Option 6 include only costs associated with constructing the lagoons for the dredge materials. The site preparation costs for Option 6 are $7,005,000.

(2) Operation and Maintenance Costs

Operation and maintenance costs are the costs incurred in the day to day operation of the facility. Such costs include personnel, equipment, record keeping, water quality monitoring, and leachate collection and treatment. The operation and maintenance costs for this option are $250,000 per year, assuming that the disposal of wastes from this facility will be completed in one year from date of disposal operations initiation.

(3) Site Closure Costs

Site closure is the work associated with abandoning the facility when it has completed its operations. These costs include the placement of final cover, seeding, fertilizing and mulching, placement of the membrane liner, installation of gas venting trenches in the lagoon areas, and the costs for the north ditch area, including installation of the leachate collection system and slurry cutoff walls, and the placement of the final cover on the north area.

TABLE 12
Site Closure Costs - Option 6

North Ditch Area	$2,325,000
Dredge Materials	$1,163,000
TOTAL	$3,488,000

(4) Long-Term Care Costs

Long-term care includes the annual inspections and maintenance work necessary after the site has been abandoned to maintain its integrity and function. Such costs include site inspections, site grading, seeding to replace eroded areas, leachate collection and treatment, water quality and gas monitoring, and recordkeeping. The costs for long-term care are the same for both options, $66,000 for the north area and $66,000 for the dredged materials.

(5) Cost Summary

The following table summarizes the costs associated with Option 6.

TABLE 13
Cost Summary - Option 6

	NORTH AREA	HARBOR MATERIAL	TOTALS
Site Preparation	$ 0	$7,005,000	$ 7,005,000
Operation and Maintenance	$ 0	$ 250,000	$ 250,000
Site Closure	$2,325,000	$1,163,000	$ 3,488,000
Long-Term Care	$ 66,000	$ 66,000	$ 132,000
Total	$2,391,000	$8,484,000	$10,875,000

d. Summary - Option 6

This option maximizes the use of slurry cutoff wall abatement at the site, and similar to Option 5, proposes the use of the coke plant site for permanent disposal of the harbor dredgings. Cost-wise, this option is comparable to Option 5, mainly because of the expense of developing the permanent storage lagoon at the coke plant site.

Favorable aspects of this option are:

1. Minimal disruption of the OMC parking area.
2. Minimal handling of contaminated materials on-site, which minimizes exposure of the PCBs to the environment.

Unfavorable characteristics for this option are similar to that of Option 5 (multiple development, permanent storage at coke plant - OMC property), but also include:

1. Risk involved with the long-term reliability of the slurry cutoff wall around the entire north ditch area.

2. Because the slurry wall is a primary and long-term structure at the site and its' success partially depends on the underlying silt layer, this silt layer will have to be extensively documented within the proposed abatement area and in laboratory tests to determine its' suitability in developing this option.

7. <u>Option 7 - Disposal of all Contaminated Materials in Lagoons at Coke Plant Location</u>

a. <u>Introduction</u>

This option would construct a permanent storage lagoon at the coke plant site for disposal of the materials from the north ditch area and the materials dredged from the harbor.

b. <u>Engineering Features</u>

The construction of the lagoons includes a liner as detailed on Drawing C 9400-13. The liner, leachate collection and final cover systems utilized for this option are the same as the systems presented for the storage lagoons in Options 5 and 6 (see those discussions for design concepts).

The storage lagoons would be approximately 35 feet in height with a fill depth of 20 feet. The leachate collection system would be installed and a dry base maintained (see Drawing C 9400-13). The leachate would be collected and either treated on-site or transported off-site for treatment.

No slurry cutoff wall system would be needed for this option since the facility would be constructed above ground. The facility would have to be monitored for seepage on the exterior of the berms and groundwater monitoring wells installed to assess the integrity of the clay liner systems.

c. Summary of Costs

The following cost summary has been divided into several categories. Those categories are site preparation costs, operation and maintenance costs, site closure costs, and long-term care costs. A detailed breakdown of this cost analysis is included in Appendix G for reference.

(1) Site Preparation Costs

Site preparation costs are the costs incurred in developing a facility for disposal of waste. For Option 7, factors included in the site preparation costs are as folows: placement of recompacted clay liners and granular blankets; installation of leachate collection in underdrain system; filter cloth and impermeable membrane liner; construction of drainage swale; and miscellaneous work. The site preparation cost for this option is $7,689,000.

(2) Operation and Maintenance Costs

Operation and maintenance costs are the costs incurred in the day to day operations of the facility. Such costs include personnel, equipment, record keeping, water quality monitoring, and leachate collection and treatment. The operation and maintenance costs for this Option is $350,000 per year. This is assuming that the disposal of the wastes will be completed within one year.

(3) Site Closure Costs

Site closure is the work associated with abandoning the facility when it has completed its operations. Costs included for this option are as follows: placement of final cover, including clay, topsoil and impermeable membrane, seeding, fertilizing and mulching, installation of gas vent trenches, and miscellaneous work. The site closure cost for Option 7 is $1,260,000.

(4) Long-Term Care Costs

Long-term care includes the annual inspection and maintenance work necessary if the site has been abandoned to maintain its integrity and function. Such costs include site inspections, site grading, seeding to replace eroded areas, leachate collection and treatment, water quality and gas monitoring, and recordkeeping. The costs for long-term care for this Option are $112,000.

(5) Cost Summary

The following table summarizes the costs for Option 7.

TABLE 14
Cost Summary - Option 7

Site Preparation	$7,689,000
Operation and Maintenance Costs	$ 350,000
Site Closure Costs	$1,260,000
Long-Term Care Costs	$ 112,000
TOTAL	$9,411,000

d. Summary - Option 7

Option 7 is somewhat similar to Option 3 in that only one permanent disposal area is developed, however, in the case of Option 7, it is the storage lagoons at the coke plant site. Cost-wise, Option 7 is slightly less costly than Options 5 and 6, mainly because of the site preparation costs involved only with the development of the above ground storage lagoons in Option 7, as opposed to multiple disposal areas. In contrast, Option 7 is somewhat more costly than Options 3 and 4, which emphasize disposal and/or abatement in the north ditch area.

Favorable aspects of Option 7 include:

1. The development of one permanent storage area at the OMC site.

2. Minimal long-term leachate handling in an above ground disposal facility.

3. Minimal haul distance of contaminated material.

4. Parking area disruptions would be only moderate, as only most contaminated soils would be removed to the storage area.

5. Removes disposal facility completely from OMC parking area, which would eliminate problems of returning the site to a parking area, as compared to if a land disposal site were developed on it.

6. The storage lagoon concept may be simpler to construct than other options on-site, as dewatering of the area is not necessary prior to construction and a cutoff wall is not necessary, yet, environmental protection is comparable with other on-site disposal options.

The only unfavorable aspects of this option are similar to those previously mentioned in regard to the permanent storage lagoons at the coke plant site, including; relative unsightliness, long-term maintenance of the surface, and limiting the end use of the property.

D. Discussion of Options 1 through 7

Seven main options have been evaluated for disposing of the PCB contaminated materials from both the north ditch area and the harbor dredge materials. Two of these options are off-site facilities (Options 1 and 2), while the remaining five (Options 3 through 7) consider various on-site disposal alternatives. For comparative purposes, Table 15 presents a summary of the costs associated with each option.

1. Off-Site Disposal Options

In comparing the two off-site disposal options, both are located in sparsely populated areas, have favorable on-site soils for development and the site managements are willing to accept the wastes at their sites. CECOS has an added advantage in that it is already licensed for PCB disposal. However, the most important factor is that the BFI facility presents a much lower cost than the CECOS facility, because of the high costs of hauling to, and disposal at, the CECOS site. Tom Cavanaugh, of Illinois EPA's Landfill Permitting Section, has indicated that obtaining a permit to dispose of the PCB contaminated materials at the BFI facility would be possible.

Therefore, we recommend the BFI site over the CECOS site for disposal of the PCB contaminated materials, provided that the additional physical investigations of the site be carried out per our recommendations (refer to summary of BFI Section). Further, we recommend that the CECOS site be used only if the use of the BFI site and the on-site options become unfeasible, because of the extreme costs involved with using the CECOS site.

TABLE 15
SUMMARY OF OPTIONS

OPTION	(1) SITE PREPARATION	(2) OPERATION & MAINTENANCE	(3) SITE CLOSURE	(4) LONG-TERM CARE	TOTAL 1 - 4	USER COST Disposal	USER COST Trans.	TOTAL USER COSTS
1A (BFI)	$1,365,000	$350,000	$ 422,000	$112,000	$ 2,249,000	$14,680,000	$ 3,670,000	$18,350,000
1B (BFI)	$1,573,000	$350,000	$ 424,000	$112,000	$ 2,459,000	$14,680,000	$ 3,670,000	$18,350,000
2 (CECOS)	$1,162,000	$350,000	$ 323,000	$112,000	$ 1,947,000	$33,030,000	$23,855,000	$56,885,000
3 (OMC)	$5,852,000	$350,000	$1,463,000	$112,000	$ 7,777,000			
4 (OMC)	$5,973,000	$350,000	$1,544,000	$112,000	$ 7,979,000			
5A (OMC)	a. $3,481,000	$130,000	$ 848,000	$ 66,000	$ 4,525,000			
	b. $5,204,000	$227,000	$1,163,000	$ 66,000	$ 6,660,000			
	c. - - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -	$11,185,000			
5B (OMC)	a. $2,070,000	$130,000	$ 660,000	$ 66,000	$ 2,926,000			
	b. $5,204,000	$227,000	$1,163,000	$ 66,000	$ 6,660,000			
	c. - - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -	$ 9,586,000			

a. North Ditch Area
b. Storage Lagoons for Dredge Materials
c. Total, a + b

CONTINUED

TABLE 15
SUMMARY OF OPTIONS
(continued)

OPTION		SITE PREPARATION	OPERATION & MAINTENANCE	SITE CLOSURE	LONG-TERM CARE	TOTAL	USER COST Disposal	USER COST Trans.	TOTAL USER COSTS
6 (OMC)	a.	----------	--------	$2,325,000	$ 66,000	$ 2,391,000			
	b.	$7,005,000	$250,000	$1,163,000	$ 112,000	$ 8,484,000			
	c.	- - - -	- - - -	- - - -	- - - -	$10,875,000			
7 (OMC)		$7,689,000	$350,000	$1,260,000	$112,000	$ 9,411,000			

NOTES:
1) All Disposal facilities utilize a clay liner, leachate collection, underdrain and final cover systems.
2) Refer to the text for a description of work elements included under cost headings: Site Preparation, Operation and Maintenance, Long-Term Care, and User.
3) Options 3 to 7 are new facilities and would be constructed to comply with existing regulations.
4) Illinois EPA requires all hazardous facilities to make a deposit of $2.02/cy fee in a special fund, which is not included in any of the above costs.
5) See Appendices A through I for cost preparation data.

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2. On-Site Options

On-site disposal options evaluated range from:

1. Disposing of the materials in a completely underground facility to
2. Containing some of the contaminated material in-place utilizing a slurry cutoff wall to
3. Disposing of all the materials in an above ground facility, and
4. Various combinations of the above.

Cost-wise, Table 15 indicates that the cost of various on-site options exhibit a moderate range. Thus, cost does not become a major consideration in choosing one on-site option over another.

Each of the five on-site options have certain favorable and unfavorable characteristics, which have been discussed in the individual summaries of each option. The aspects considered for each option include disruption to the OMC parking lot area (intensity of development), reliability, simplicity and long-term maintenance of design and construction methods, on-site handling of the PCB contaminated materials and final use.

Comparison of both costs and the favorable and unfavorable aspects of all the on-site options indicate that two of the on-site options appear somewhat more favorable than the others; and include:

Option 3 - Total On-Site Excavation and Disposal in Parking Lot

Option 7 - Disposal of All Contaminated Materials in Lagoons at Coke Plant Location

These two options emerge from the group, based on their simplicity of construction, relative reliability of construction methods, minimal on-site disruption (as opposed to multiple developments) and minimal long-term care associated with one facility. Both options consider only one area as a permanent disposal facility, which would include all wastes from the harbor and OMC property.

It was felt that the multiple disposal facilities cause significant overall site disruption and would add significantly to long-term maintenance measures. Further, the long-term reliability of the clay slurry cutoff makes those options that use it as a primary containing element somewhat less attractive, especially Option 6, which confines the entire north ditch area by slurry cutoff.

Comparing Options 3 and 7, we choose Option 3 as the slightly more workable alternative, because it utilizes underground disposal space rather than above ground. The parking lot will be disrupted severely during construction of Option 3, but, it can be returned to its parking lot use.

In contrast, permanent disposal above ground, at the coke plant site in Option 7, would severely limit the potential end use of the land. Further, we indicated that an above ground facility would probably require greater long-term maintenance (especially a grassed surface) compared to an asphalt surface. However, above ground disposal may have advantages over below ground (and below water table) disposal, in that above ground disposal minimizes leachate production and precludes dewatering of the construction area for development. Also, stockpiling of contaminated sediments is generally eliminated in the above ground option. These impacts should be considered more closely in a detailed investigation to define the relative development potential of these two options.

In particular, the hydrogeology of the OMC area must be better defined to determine the soil and groundwater conditions in the parking lot and the plant sites. Documentation of the underlying silt layer in the vicinity of the parking lot is especially important in defining the ultimate developability of Option 3.

As with all the on-site options, the disposal of PCB contaminated materials at the OMC property may be contingent upon:

1. The permission of OMC management.
2. The acceptability of these options to the Illinois EPA.
3. Presently unidentified socio-political opposition.

3. <u>Comparison of Recommended Off-Site and On-Site Disposal Options</u>

The comparison of the on-site alternatives to the off-site alternatives is made difficult by the lack of information regarding:

1. OMC's position on permanent disposal on-site and long-term care commitments.
2. The political acceptability of on-site disposal with respect to IEPA and potential local opposition to on-site disposal.
3. The feasilibity of on-site disposal as determined from on-site hydrogeological investigations.
4. Final design concepts for either the BFI site or on-site disposal options.
5. The relative quickness in which the BFI site or on-site options could be licensed for PCB disposal by State and Federal Agencies (on-site licensing would obviously be slower).
6. Site specific feasibility investigations at the BFI site.

Based on costs, the on-site options appear to be more attractive than disposal at the BFI site, but, despite cost, BFI would likely be much easier to license and develop. However, it is premature to make decisions as to the most desirable option until the recommended investigations are performed.

PROCEDURES REQUIRED FOR PERMITTING SITES FOR DEVELOPMENT

Removal, transport and disposal of the OMC PCB waste is regulated by various Federal, State and Local agencies. The Federal agencies which have jurisdiction are the United States Environmental Protection Agency (EPA) and the United States Department of Transportation (DOT). Depending on which state (Illinois or Ohio) disposal of the waste material takes place in, the Illinois Environmental Protection Agency or the Ohio Environmental Protection Agency will be the State Regulatory Body. Local governments have jurisdication in the form of zoning and land use ordinances. These would affect disposal if a new hazardous waste site were being proposed or if an existing solid waste disposal facility were to be upgraded to accept hazardous waste material. Table 16 lists permits required for disposal of the PCB waste. The following discussion outlines the purpose and procedure for obtaining the permits.

A. Federal

The Toxic Substances Control Act (TSCA) 1976 requires premarket toxicological testing of all new chemicals and imposes strict regulations governing their use, sale and disposal. Broad powers are given for banning, limiting or modifying use, manufacturing and processing of a substance which could pose an unreasonable risk to human health or to the environment. PCB Disposal is strictly regulated under provisions of this Act.

TABLE 16
SUMMARY OF REGULATORY REQUIREMENTS

Disposal Option	Regulatory Agency	Regulatory Authority	Permit Req'd	Type of Permit Required
On-Site Storage & Processing (Temporary)	Illinois EPA	Illinois Environmental Protection Agency	Yes	NPDES - For Effluent Returning to Surface Water IEPA - For Construction of Processing & Storage Facility
	USEPA	TSCA	Yes	USEPA - For Construction of PCB Handling Facility
On-Site Disposal	Illinois EPA	Illinois Environmental Protection Agency	Yes	IEPA - Permit to Develop and/or Operate a Solid Waste Management Site
	USEPA	TSCA	Yes	EPA - Permit to Dispose of PCB Waste Material
Disposal at Browning-Ferris Industries (BFI) Site	Illinois EPA	Illinois Environmental Protection Agency	Yes	IEPA - Supplemental Permit for Special Waste Handling at Existing Solid Waste Disposal Site
	USEPA	TSCA	Yes	USEPA - For Construction of PCB Disposal Facility
Disposal at CECOS Site	Ohio EPA	Ohio Revised Code Section 3734	No*	
	USEPA	TSCA	No*	

* The CECOS Site is currently licensed by the Ohio EPA and the USEPA to receive PCB waste.

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The May 31, 1979 Federal Register contains the final rule implementing provisions of the Toxic Substances Control Act (TSCA) 40 CFR Part 761 prohibiting the manufacture, processing, distribution in commerce and use of PCB's. Annex II of TSCA specifies the licensing procedure for obtaining EPA approval.

Prior to the disposal of any PCB's or PCB items, the owner or operator of the landfill shall receive written approval from the EPA Regional Administrator for the region in which the landfill is located.

The owner or operator shall submit to the regional administrator a detailed initial report describing physical site conditions, outlining the design and operating procedures, and other information the regional administrator deems to be necessary to make a final determination. Specific information which must be included is listed in the May 31, 1979 rules.

Implementing any of the disposal options in Illinois will require a permit to be obtained under provisions of this Act. Disposal of the waste at the CECOS site in Ohio is acceptable because that site has a permit to accept PCB waste material. Temporary processing and storage on-site will require approval also.

The Hazardous Materials Transportation Act, 1974, regulates transportation of a wide range of substances including toxic chemicals. The act sets standards for containers and requires registration of transporters. These regulations have been revised in 1980 to explicitly address the transportation hazards of waste materials. In addition, the revised transportation rules governing hazardous waste apply to intrastate as well as the interstate transportation of waste.

B. State

If the PCB waste material is disposed of in the State of Illinois, the Illinois Enviromental Protection Agency (IEPA) will require a permit or supplemental permit to be granted under the State of Illinois Environmental Protection Act. These permits will be required both for the development of a new facility or upgrading of an existing facility respectively. IEPA has indicated that the simplest option to pursue would be to obtain a supplemental permit to dispose of the PCB waste at the BFI site. They have also stated that they would oppose permanent on-site disposal of the PCB waste.

The Ohio disposal option includes transport and disposal of the PCB waste at the CECOS Land Disposal site in Clermont County, Ohio, a licensed PCB disposal site. The Ohio Environmental Protection Agency (OEPA) does not require additional permits for disposal of the PCB waste at the CECOS hazardous waste disposal site. That site is currently licensed to accept PCB waste between 50-500 ppm and will not require any special permitting procedures for the waste to be deposited there.

The following discussion will describe the regulatory requirements for disposal of PCB wastes in Illinois. Two disposal options are being considered in Illinois. Those options are: 1) On-site disposal at the OMC Waukegan site, and 2) transport to the Browning-Ferris Industries (BFI) land disposal site. The BFI site is not currently licensed to accept PCB waste.

Since exercising of either option for disposal of the PCB waste in Illinois will require submission of similar information and compliance with the same regulations, the procedure will be outlined only once. Implementing the option of disposing of the PCB waste at the BFI site may be somewhat less time consuming and expensive, since much of the on-site information which is required to be submitted has been gathered and compiled. Preparation of supplemental data would be required to license that site as a PCB disposal area. The procedures outlined do not address any waivers or special treatment which the IEPA or USEPA deem necessary for disposal or temporary storage of the PCB waste.

The procedures for application to expand an existing land disposal site or create a new land disposal site are specified in the State of Illinois Environmental Protection Act, Public Act 76-2429, with the application criteria delineated in the permit application pamphlet, Application For Permit To Develop and/or Operate A Solid Waste Management Site.

By complying with the requirements of the above referenced act, and including the required information in the application pamphlet, the applicant can initiate IEPA review procedures. In some cases, IEPA will request preliminary site information from the Illinois State Geological Survey to assist in forming a tentative opinion of the suitabiliy of the proposed site for use as a solid waste disposal site. Upon request and submission of a legal description of the site by the applicant, IEPA will render a tentative opinion. An unfavorable report does not imply that the site cannot be changed to remove, correct, or modify the limitations. Rather, the use of the site will depend on the kind of limitations, and whether or not these can be altered successfully and economically. The above preliminary site determination will help to eliminate some of the expense to the applicant of preparing plans and reports for a site which is unsuitable or where such use might be uneconomical.

Immediately upon receipt of a request for a permit or supplemental permit for a refuse disposal facility, IEPA will notify the State's Attorney and the Chairman of the County Board of the County in which the facility is located along with each member of the General Assembly from the legislative district in which the proposed facility is located and to the Clerk of each municipality within three miles of the proposed facility. Prior to the issuance of a permit to develop a hazardous waste disposal site, IEPA shall conduct a public hearing in the County where the site is proposed to be located.

IEPA has 180 days after the filing of the application for permit to reject or approve the application. The 180-day time period includes the public hearing procedure which is required for a hazardous waste landfill permit.

If IEPA refuses to grant a permit for the development of a land disposal site, the applicant may, within 35 days, petition for a hearing before the Pollution Control Board to contest the decision of IEPA. After a 21-day public notice period, the Pollution Control Board has 90 days to respond to the applicant. In addition, if IEPA grants a permit to develop a hazardous waste disposal site, a third party, other than the permit applicant or IEPA, may petition the Pollution Control Board within 35 days for a hearing to contest the issuance of the permit. The above time limitations also apply to this hearing request. The hearing will not be granted if the Pollution Control Board determines that the hearing would be a duplication of previous hearings or information already received.

Upon approval of the permit application, the applicant may begin site preparation work. The applicant must notify IEPA in writing when the development of the site has been completed for the required pre-operation site inspection. An operating permit will be issued if the site development is in accordance with the development permit.

The State of Illinois Environmental Protection Act creates a "hazardous waste fund" which will be comprised from the fees collected pursuant to Section 22.2 of the above Act. That Section specifies a fee in the amount of 1¢ per gallon or $2.02 per cubic yard of hazardous wastes received on and after the effective date of procedures established by IEPA not later than April 1, 1980. The fee will be paid by the owner or operator of the hazardous waste disposal site.

C. Local

Presently, there are no local zoning or land use ordinaces preventing PCB disposal at the Browning-Ferris Industries (BFI) site. Some public opposition to disposal of the PCB wastes at that site will likely occur, but it is not expected that the opposition could prevent disposal of the PCB dredge materials at the site. The BFI site has been licensed to accept PCB waste in the past and therefore complies with local ordinances.

On-site disposal of the PCB waste material would not be affected by any local zoning or land use ordinances. Temporary storage of the waste materials or permanent on-site disposal may meet with public opposition but it is uncertain as to whether this opposition could prevent exersizing that alternative.

The CECOS site in Ohio is currently licensed to accept PCB waste and therefore complies with all existing zoning or land use ordinances.

D. Transportation of PCB Waste

A transporter may not handle hazardous wastes without an EPA identification number, which can be obtained by using EPA Form 8700-12. Both the EPA and the DOT regulate transportation of PCB wastes. The DOT regulates the transportation of hazardous wastes under the authority provided by the Hazardous Materials Transportation Act of 1978. These regulations have been revised during 1980 to explicitly address the transportation hazards of waste materials. In addition, the revised transportation rules governing hazardous waste applied to intrastate as well as the interstate transporation of waste.

Both shippers and transporters of hazardous waste must comply with DOT's special requirements concerning the classification, description, packaging, marking, labeling and preparation for shipping of these materials. The shipper must appropriately package and mark the waste materials, comply with certain record-keeping requirements that duplicate the EPA rules, and certify that the materials offered for transport are in compliance with the applicable DOT rules.

The transporter assumes the obligation to specially mark each motor vehicle used to carry hazardous waste regardless of the amount of waste transported.

SUMMARY AND RECOMMENDATIONS

As a result of this study, we provide the following summary and recommendations:

1. Disposal of the PCB contaminated sediments at the BFI site is more cost effective than disposal at the CECOS-Williamsburg, Ohio, site based primarily on the high costs of transportation and disposal at the CECOS site.

2. On-site disposal Options 3 and 7 at the OMC property appear to be the most feasible based on simplicity of construction, minimal long-term care factors and minimal on-site disruption during construction. Option 3 has wastes from the harbor and north ditch area disposed underground in a secured landfill developed in the parking lot area, while Option 7 disposes the waste in an above ground storage lagoon facility at the nearby coke plant site.

3. A decision as to which of the on-site (Options 3 and 7) or off-site (BFI) disposal alternatives is most desirable cannot be made until more detailed investigations are performed. Based on the cost of disposal above, the on-site options appear to be more cost effective.

4. It may be advisable to presently install a slurry cutoff wall around the north ditch area to limit further migration of the PCB contamination. Hydrogeolgical investigations to further assess the potential on-site disposal developability are necessary to implement this abatement procedure.

5. Site specific studies need to be performed at both the BFI and OMC sites to further assess what potential modifications are required to accommodate PCB disposal in an environmentally sound manner.

6. The CECOS site should be considered for PCB disposal only after all other options are considered unfeasible based on unexpectd socio-political opposition or technical consideration which would prohibit development at the recommended sites.

7. If an on-site disposal option is considered desirable, a clay borrow search should be conducted to identify potential sources of clay liner and capping materials.

CLOSING REMARKS

We trust that this investigation has been performed to your satisfaction and is consistent with your needs. We enjoyed the opportunity to serve Mason Hanger-Silas Mason Company, Inc. and look forward to future working relationships.

If you have any questions or comments about the content or conclusions of this report, please contact us.

Respectfully submitted,

WARZYN ENGINEERING INC.

Roger C. Cooley

Roger C. Cooley, P.E.
Project Engineer

Daniel W. Hall

Daniel W. Hall, CPGS
Project Manager

APPENDIX A

BFI SITE OPTION 1A and OPTION 1B

WARZYN
ENGINEERING INC

C 9400

OMC-WAUKEGAN
BFI SITE - OPTION 1A
(20' ABOVE/10' BELOW GND SURFACE)
COSTS - SITE PREPARATION

Item	Quantity	Unit Cost	Cost
Excavation	312,851 c.y.	$1.00/c.y.	$ 312,851.00
Granular Blankets	25,827 c.y.	$7.50/c.y.	$ 193,702.50
Recompacted Clay Liner	129,709 c.y.	$1.50/c.y.	$ 194,563.50
Excavate & Recompact Clay Below Underdrain	34,436 c.y.	$2.50/c.y.	$ 86,090.00
Leachate Collection System			
Pipe	3,371 l.f.	$7.50/l.f.	$ 25,282.50
Manhole	($595 + (25'-8')$78 + $160) 6[1]		$ 12,486.00
Underdrain System			
Pipe	2,830 l.f.	$7.50/l.f.	$ 21,225.00
Manhole	($595 + (31'-8')$78 + $160) 4[1]		$ 10,196.00
Filter Cloth	464,880 s.f.	$0.11/s.f.	$ 51,136.80
Liner - PVC Membrane	608,482 s.f.	$0.35/s.f.	$ 212,968.70
Strip Topsoil	9,959 c.y.	$0.85/c.y.	$ 8,465.15
Drainage Swale	3,154 l.f.	$3.50/l.f.	$ 11,039.00
Engineering		Lump Sum	$ 100,000.00
		Subtotal	$1,240,006.15
		10% Contingency	124,000.62
		TOTAL	$1,364,006.77[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

OMC-WAUKEGAN
BFI SITE - OPTION 1A
(20' ABOVE/10' BELOW GND SURFACE)
SITE CLOSURE

Item	Quantity	Unit Cost	Cost
Final Cover Placement	77,370 c.y.	$1.30/c.y.	$ 100,581.00
Topsoil Placement	61,896 s.y.	$0.30/s.y.	$ 18,568.80
Seed, Fertilizer & Mulch	61,896 s.y.	$0.32/s.y.	$ 19,806.72
Liner - PVC Membrane	584,917 s.f.	$0.35/s.f.	$ 204,720.95
Gas Venting			
Gravel	2,211 tons	$6.00/ton	$ 13,266.00
Vents	5	$200/each	$ 1,000.00
Engineering		Lump Sum	$ 25,000.00
		Subtotal	$ 382,943.47
		10% Contingency	$ 38,294.35
		TOTAL	$ 421,237.82[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

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WARZYN ENGINEERING INC

OMC-WAUKEGAN
BFI SITE - OPTION 1B
(BELOW GND SURFACE)
SITE PREPARATION

Item	Quantity	Unit Cost	Cost
Excavation	505,011 c.y.	$1.00/c.y.	$ 505,011.00
Granular Blankets	24,197 c.y.	$7.50/c.y.	$ 181,477.50
Recompacted Clay	134,158 c.y.	$1.50/c.y.	$ 201,237.00
Excavate & Recompact Clay below Underdrain	31,835 c.y.	$2.50/c.y.	$ 79,587.50
Leachate Collection System			
Pipe	3,271 l.f.	$7.50/l.f.	$ 24,532.50
Manhole	($595 + (25' - 8')	$78 + 160) 6[1]	$ 12,486.00
Underdrain System			
Pipe	2,646 l.f.	$7.50/l.f.	$ 19,845.00
Manhole	($595 + (31' - 8')	$78 + 160) 4[1]	$ 10,196.00
Drainage Swale	3,254 l.f.	$3.50/l.f.	$ 11,389.00
Filter Cloth	435,540 s.f.	$0.11/s.f.	$ 47,909.40
Strip Topsoil	10,992 c.y.	$0.85/c.y.	$ 9,343.20
Liner - PVC Membrane	647,332 s.f.	$0.35/s.f.	$ 226,566.20
Engineering		Lump Sum	$ 100,000.00
		Subtotal	$1,429,580.30
		10% Contingency	$ 142,958.03
		TOTAL	$1,572,538.33[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

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OMC-WAUKEGAN
BFI SITE - OPTION 1B
(BELOW GND SURFACE)
SITE CLOSURE

Item	Quantity	Unit Cost	Cost
Final Cover Placement	77,459 c.y.	$1.30/c.y.	$100,696.70
Topsoil Placement	61,967 s.y.	$0.30/s.y.	$ 18,590.10
Seed, Fertilize and Mulch	61,967 s.y.	$0.32/s.y.	$ 19,829.44
PVC Liner	585,588 s.f.	$0.35/s.f.	$204,955.80
Gas Venting			
Gravel	2454 tons	$6.00/ton	$ 14,724.00
Vents	5	$200.00/each	$ 1,000.00
Engineering		Lump Sum	$ 25,000.00
		Subtotal	$384,796.04
		10% Contingency	$ 38,479.60
		TOTAL	$423,275.64[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

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WARZYN ENGINEERING INC

APPENDIX B

CECOS - WILLIAMSBURG - OPTION 2

Cost Summary Cont'd.

OMC Site - Option 6

North Area Disposal

1)	Site Preparation	----------
2)	Operational Cost	----------
3)	Site Closure	$2,325,000
4)	Long-Term Care	66,000
	Total	$2,391,000

Harbor Dredged Material Disposal

1)	Site Preparation	$7,005,000
2)	Operational Cost	250,000
3)	Site Closure	1,163,000
4)	Long-Term Care	112,000
	Total	$8,484,000

OMC Site - Option 7

1)	Site Preparation	$7,689,000
2)	Operational Cost	350,000
3)	Site Closure	1,260,000
4)	Long-Term Care	112,000
	Total	$9,411,000

Note:

The above costs have been rounded up to the next thousand.

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Cost Summary Cont'd.

OMC Site - Option 5A

North Area Disposal

1)	Site Preparation	$3,481,000
2)	Operational Cost	130,000
3)	Site Closure	848,000
4)	Long-Term Care	66,000
	Total	$4,525,000

Harbor Dredged Material Disposal

1)	Site Preparation	$5,204,000
2)	Operational Cost	227,000
3)	Site Closure	1,163,000
4)	Long-Term Care	66,000
	Total	$6,660,000

OMC Site - Option 5B

North Area Disposal

1)	Site Preparation	$2,070,000
2)	Operational Cost	130,000
3)	Site Closure	660,000
4)	Long-Term Care	66,000
	Total	$2,926,000

Harbor Dredged Material Disposal

1)	Site Preparation	$5,204,000
2)	Operational Cost	227,000
3)	Site Closure	1,163,000
4)	Long-Term Care	66,000
	Total	$6,660,000

OMC-WAUKEGAN
COST SUMMARY

BFI Site - Option 1A (20' Above/10' Below GND. Surface)

1)	Site Preparation	$1,365,000
2)	Operational Cost	350,000
3)	Site Closure	422,000
4)	Long-Term Care	112,000
	Total	$2,249,000

BFI Site - Option 1B (Below GND. Surface)

1)	Site Preparation	$1,573,000
2)	Operational Cost	350,000
3)	Site Closure	424,000
4)	Long-Term Care	112,000
	Total	$2,459,000

CECOS-Williamsburg - Option 2

1)	Site Preparation	$1,162,000
2)	Operational Cost	350,000
3)	Site Closure	323,000
4)	Long-Term Care	112,000
	Total	$1,947,000

OMC Site - Option 3

1)	Site Preparation	$5,852,000
2)	Operational Cost	350,000
3)	Site Closure	1,463,000
4)	Long-Term Care	112,000
	Total	$7,777,000

OMC Site - Option 4

1)	Site Preparation	$5,973,000
2)	Operational Cost	350,000
3)	Site Closure	1,544,000
4)	Long-Term Care	112,000
	Total	$7,979,000

WARZYN ENGINEERING INC

APPENDIX I

COST SUMMARY

OMC-WAUKEGAN
LONG-TERM CARE (20 YEARS)

Site Inspections 2 inspections/year at $500/inspection for 3 years, 1 inspection/year for following 17 years	$ 12,000
Site Grading $2000/year for 5 years	$ 10,000
Seeding $1,000/year for 10 years	$ 10,000
Water Quality and Gas Monitoring $3,000/year	$ 60,000
Leachate Collection & Treatment PVC Liner 3 gal./yr. x $0.05/gal. = $0.15/yr. (CLay Liner 2.15 x 10^5 gal/yr. x $0.05/gal. = $10,750 yr.)	Neglectable[1] ($215,000)[2]
Record Keeping $1,000/year for 20 years	$ 20,000
TOTAL	$112,000

Notes:

1. Regardless of the low leachate generation, due to the membrane liner in the final cover, it is assumed that dewatering of the waste following the site closure will be required.

2. If no PVC liner was used in conjunction with the final clay cover, leachate generation would be approximately 2.15 x 10^5 gal./yr. at a cost of $10,750/yr. or $215,000 for 20 year period.

3. Long-term care costs ($112,000) are based on the maintenance of one disposal site. Where more than one disposal and/or abatement site are considered (Options 5 and 6) at the OMC facility, long-term care costs were estimated at $66,000/site, or a total of $132,000 for the two sites at the OMC facility.

OMC WAUKEGAN
OPERATION COSTS

Employees		
Manager	\$25,000	
Operator	\$20,000	\$60,000/yr.
Clerical	\$15,000	
Equipment		
Dozer	\$ 7,000/yr.	
Scraper	\$17,000/yr.	\$37,000/yr.
Fuel	\$ 8,000/yr.	
Main.	\$ 5,000/yr.	
Record Keeping/Clerical		
Supplies \$2,000		\$ 2,000/yr.
Misc. Expenses		\$10,000/yr.

Monitoring

6 Wells - \$4,000 install

Sampling - \$500/trip = \$ 7,000

Testing \$250/trip $\frac{4 \text{ trip}}{\text{yr.}}$

Leachate Collection & Treatment

$$500{,}000 \text{ ft}^2 \times \frac{30''}{\text{yr.}} \times \frac{1'}{12''} \times \frac{7.48 \text{ gal.}}{\text{C.F.}} = 9.36 \times 10^6 \text{ gal./yr.}$$

6 months = 4.68×10^6 gal.

4.68×10^6 gal. x \$0.05/gal. = \$234,000

TOTAL \$350,000

Note:

1. The State of Illinois has a \$2.02/c.y. of disposed material charge for future funding purposes. At this time no fund of this kind is known to be in affect in Ohio for the CECOS-Williamsburg Site.

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APPENDIX H

OPERATION COSTS AND LONG TERM CARE COSTS

WARZYN
ENGINEERING INC

C 9400

OMC-WAUKEGAN
OMC SITE - OPTION 7
SITE CLOSURE

Item	Quantity	Unit Cost	Cost
Final Cover	85,716 c.y	$9.00/c.y.	$ 771,444.00
Topsoil	11,429 c.y.	$9.00/c.y.	$ 102,861.00
Liner - PVC Membrane	648,019 s.f.	$0.35/s.f.	$ 226,806.65
Gas Venting			
Gravel	111 tons	$6.00/ton	$ 666.00
Vents	6	$200/each	$ 1,200.00
Seed, Fertilize, Mulch	68,573 s.y.	$0.32/s.y.	$ 21,943.36
Engineering		Lump Sum	$ 20,000.00
		Subtotal	$1,144,921.01
		10% Contingency	$ 114,492.10
		TOTAL	$1,259,413.11[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

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APPENDIX G

OMC SITE - OPTION 7

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 6
SITE CLOSURE - (HARBOR MATERIAL DISPOSAL)

Item	Quantity	Unit Cost	Cost
Final Cover	79,359 c.y	$9.00/c.y.	$714,231.00
Topsoil	10,580 c.y.	$9.00/c.y.	$ 95,220.00
Liner - PVC Membrane	599,950 s.f.	$0.35/s.f.	$209,982.50
Gas Venting			
Gravel	107 tons	$6.00/ton	$ 642.00
Vents	6	$200/each	$ 1,200.00
Seed, Fertilize, Mulch	63,487 s.y.	$0.32/s.y.	$ 20,315.84
Engineering		Lump Sum	$ 15,000.00
		Subtotal	$1,056,591.34
		10% Contingency	$ 105,659.13
		TOTAL	$1,162,250.47[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

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WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 6
SITE PREPARATION - (HARBOR MATERIAL DISPOSAL)

Item	Quantity	Unit Cost	Cost
General Fill Material	382,580 c.y.	$7.50/c.y.	$2,869,350.00
Clay Liner	309,288 c.y.	$9.00/c.y.	$2,783,592.00
Granular Material	21,074 c.y.	$7.50/c.y.	$ 158,055.00
Filter Cloth	379,320 s.f.	$0.11/s.f.	$ 41,725.20
Liner - PVC Membrane	715,078 s.f.	$0.35/s.f.	$ 250,277.30
Leachate Collection System			
Pipe	4,250 l.f.	$7.50/l.f.	$ 31,875.00
Manhole	($595 + (20'-8')$78 + $160) 12[1]		$ 20,292.00
Underdrain System			
Pipe	3,400 l.f	$7.50/l.f.	$ 25,500.00
Manhole	($595 + (26'- 8')$78 + $160) 8[1]		$ 17,272.00
Drainage Swale	4,476 l.f.	$3.50/l.f.	$ 15,666.00
Topsoil Berms	7,232 c.y.	$9.00/c.y.	$ 65,088.00
Seed, Fertilize, Mulch	43,394 s.y.	$0.32/s.y.	$ 13,886.00
Engineering		Lump Sum	$ 75,000.00
		Subtotal	$6,367,578.50
		10% Contingency	$ 636,757.85
		TOTAL	$7,004,336.35[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 6
SITE CLOSURE - (NORTH AREA DISPOSAL)

Item	Quantity	Unit Cost	Cost
Slurry Trench	189,000 s.f.	$3.50/s.f.	$ 661,500.00
Bituminous Pavement	676,500 s.f.	$0.55/s.f.	$ 372,075.00
Drainage Swale	5,400 l.f.	$3.50/l.f.	$ 18,900.00
Final Cover	75,167 c.y.	$9.00/c.y.	$ 676,503.00
Liner - PVC Membrane	676,500 s.f.	$0.35/s.f.	$ 236,775.00
Relocate Utilities		Lump Sum	$ 50,000.00
Leachate Collection System			
Pipe	5,000 l.f.	$9.50/l.f.	$ 47,500.00
Manhole	($595 + $160) 6[1]		$ 4,530.00
Gas Venting System			
Gravel	2,490 tons	$6.00/ton	$ 14,940.00
Vents	4	$200/each	$ 800.00
Engineering		Lump Sum	$ 30,000.00
		Subtotal	$2,113,523.00
		10% Contingency	$ 213,352.30
		TOTAL	$2,324,875.30[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

3. See Appendix H for Site Operation and Long-Term Care Costs.

WARZYN ENGINEERING INC

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APPENDIX F

OMC SITE - OPTION 6

OMC-WAUKEGAN
OMC SITE - OPTION 5B
SITE CLOSURE - (NORTH AREA DISPOSAL)

Item	Quantity	Unit Cost	Cost
Final Cover Parking Lot	36,942 c.y.	$9.00/c.y.	$332,478.00
Gas Venting System			
Gravel	1,212 tons	$6.00/ton	$ 7,272.00
Vents	3	$200/each	$ 600.00
Liner - PVC Membrane	279,279 s.f.	$0.35/s.f.	$ 97,747.65
Bituminous Pavement	265,980 s.f.	$0.55/s.f.	$146,289.00
Engineering		Lump Sum	$ 15,000.00
		Subtotal	$599,386.65
		10% Contingency	$ 59,938.67
		TOTAL	$659,325.32[1]

ote:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

OMC-WAUKEGAN
OMC SITE - OPTION 5B
(HARBOR MATERIAL DISPOSAL)

Costs For Both Site Preparation And Site Closure Are The Same As OMC SITE - OPTION 5A.

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 5B
SITE PREPARATION-(NORTH AREA DISPOSAL)

Costs

Item	Quantity	Unit Cost	Cost
Excavation	242,274 c.y.	$1.00/c.y.	$ 242,274.00
On-site Disposal of Excavated Material	242,274 c.y.	$1.50/c.y.	$ 363,411.00
Recompacted Clay	74,917 c.y.	$9.00/c.y.	$ 674,253.00
Filter Cloth	135,200 s.f.	$0.11/s.f.	$ 14,872.00
Granular Material	7,511 c.y.	$2.50/c.y.	$ 18,777.50
Liner - PVC Membrane	285,595 s.f.	$0.35/s.f.	$ 99,958.25
Leachate Collection System			
Pipe	1,957 l.f.	$7.50/l.f.	$ 14,677.50
Manhole	($595 + (23'- 8')$78 + $160) 6[1]		$ 11,550.00
Underdrain System			
Pipe	1,704 l.f	$7.50/l.f	$ 12,780.00
Manhole	($595 + (29'- 8')$78 + $160)4[1]		$ 9,572.00
Slurry Trench Dewatering	87,500 s.f.	$3.50/s.f.	$ 306,250.00
Drainage Swale	2,300 l.f.	$3.50/l.f.	$ 8,050.00
Relocate Utilities		Lump Sum	$ 30,000.00
Engineering		Lump Sum	$ 75,000.00
		Subtotal	$1,881,425.25
		10% Contingency	$ 188,142.53
		TOTAL	$2,069,567.78[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 5A
SITE CLOSURE - (HARBOR MATERIAL DISPOSAL)

Item	Quantity	Unit Cost	Cost
Final Cover	79,359 c.y	$9.00/c.y.	$ 714,231.00
Topsoil	10,580 c.y.	$9.00/c.y.	$ 95,220.00
Liner - PVC Membrane	599,950 s.f.	$0.35/s.f.	$ 209,982.50
Gas Venting			
Gravel	107 tons	$6.00/ton	$ 642.00
Vents	6	$200/each	$ 1,200.00
Seed, Fertilize, Mulch	63,487 s.y.	$0.32/s.y.	$ 20,315.84
Engineering		Lump Sum	$ 15,000.00
		Subtotal	$1,056,591.34
		10% Contingency	$ 105,659.13
		TOTAL	$1,162,250.47[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

[WEI 8-60]
pag

WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 5A
SITE PREPARATION - (HARBOR MATERIAL DISPOSAL)

Costs

Item	Quantity	Unit Cost	Cost
General Fill Material	164,250 c.y.	$7.50/c.y.	$1,231,875.00
Clay Liner	309,288 c.y.	$9.00/c.y.	$2,783,592.00
Granular Material	21,074 c.y.	$7.50/c.y.	$ 158,055.00
Filter Cloth	379,320 s.f.	$0.11/s.f.	$ 41,725.20
Liner - PVC Membrane	715,078 s.f.	$0.35/s.f.	$ 250,277.30
Leachate Collection System			
Pipe	4,250 l.f.	$7.50/l.f.	$ 31,875.00
Manhole	($595 + (20'-8')$78 + $160) 12[1]		$ 20,292.00
Underdrain System			
Pipe	3,400 l.f	$7.50/l.f.	$ 25,500.00
Manhole	($595 + (26'- 8')$78 + $160) 8[1]		$ 17,272.00
Drainage Swale	4,476 l.f.	$3.50/l.f.	$ 15,666.00
Topsoil Berms	7,232 c.y.	$9.00/c.y.	$ 65,088.00
Seed, Fertilize, Mulch	43,394 s.y.	$0.32/s.y.	$ 13,886.00
Engineering		Lump Sum	$ 75,000.00
		Subtotal	$4,730,103.50
		10% Contingency	$ 473,010.35
		TOTAL	$5,203,113.85[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

[WEI 8-59]
pag

OMC-WAUKEGAN
OMC SITE - OPTION 5A
SITE CLOSURE - (NORTH AREA DISPOSAL)

Item	Quantity	Unit Cost	Cost
Final Cover Parking Lot	40,334 c.y.	$9.00/c.y.	$363,006.00
Gas Venting System Gravel Vents	 1,262 tons 3	 $6.00/ton $200/each	 $ 7,572.00 $ 600.00
Liner - PVC Membrane	304,920 s.f.	$0.35/s.f.	$106,722.00
Bituminous Pavement	370,599 s.f.	$0.55/s.f.	$203,829.45
Final cover In-situ Disposal	5,000 c.y.	$9.00/c.y.	$ 45,000.00
Gas Venting System In-Situ Disposal Gravel Vents	 567 tons 2	 $6.00/ton $200/each	 $ 3,402.00 $ 400.00
Liner - PVC Membrane	45,000 s.f.	$0.35/s.f.	$ 15,750.00
Topsoil	833 c.y.	$9.00/c.y.	$ 7,497.00
Seed, Fertilize and Mulch	5,000 s.y.	$0.32/s.y.	$ 1,600.00
Engineering		Lump Sum	$ 15,000.00
		Subtotal	$770,378.45
		10% Contingency	$ 77,037.85
		TOTAL	$847,416.30[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

WARZYN ENGINEERING INC

[WEI 8-58]
pag

OMC-WAUKEGAN
OMC SITE - OPTION NO. 5A
SITE PREPARATION-(NORTH AREA DISPOSAL)

(Cont'd)

Costs

Item	Quantity	Unit Cost	Cost
Relocate Utilities		Lump Sum	$ 50,000.00
Engineering		Lump Sum	$ 75,000.00
		Subtotal	$3,163,916.45
		10% Contingency	$ 316,391.65
		TOTAL	$3,480,308.10[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 5A
SITE PREPARATION-(NORTH AREA DISPOSAL)

Costs

Item	Quantity	Unit Cost	Cost
Excavation	233,105 c.y.	$1.00/c.y.	$ 233,105.00
On-site Disposal of Excavated Material	233,105 c.y.	$1.50/c.y.	$ 349,657.50
Recompacted Clay	184,383 c.y.	$9.00/c.y.	$1,659,447.00
Filter Cloth	200,000 s.f.	$0.11/s.f.	$ 22,000.00
Granular Material	12,938 c.y.	$2.50/c.y.	$ 32,345.00
Liner - PVC Membrane	464,657 s.f.	$0.35/s.f.	$ 162,629.95
Leachate Collection System			
Pipe	2,350 l.f.	$7.50/l.f.	$ 17,625.00
Manhole	($595 + (15'- 8')$78 + $160) 6[1]		$ 7,806.00
Underdrain System			
Pipe	1,824 l.f	$7.50/l.f	$ 13,680.00
Manhole	($595 + (26'- 8')$78 + $160) 4[1]		$ 8,636.00
Slurry Trench In-situ Disposal	52,500 s.f.	$3.50/s.f.	$ 183,750.00
Slurry Trench Dewatering	94,500 s.f.	$3.50/s.f.	$ 330,750.00
Leachate Collection In-situ Disposal			
Pipe	840 l.f.	$9.50/l.f.	$ 7,980.00
Manhole	1	$595 + $160[1]	$ 755.00
Drainage Swale	2,500 l.f.	$3.50/l.f.	$ 8,750.00

WARZYN ENGINEERING INC

APPENDIX E

OMC SITE - OPTION 5A and OPTION 5B

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 4
SITE CLOSURE

Item	Quantity	Unit Cost	Cost
Final Cover Parking Lot	77,916 c.y.	$9.00/c.y.	$ 701,244.00
Gas Venting			
Gravel	2,484 tons	$6.00/ton	$ 14,904.00
Vents	6	$200/each	$ 1,200.00
Liner - PVC Membrane	589,050 s.f.	$0.35/s.f.	$ 206,167.00
Bituminous Pavement	692,859 s.f.	$0.55/s.f.	$ 381,072.45
Final Cover In-situ Disposal	5,000 c.y.	$9.00/c.y.	$ 45,000.00
Gas Venting In-Situ Disposal			
Gravel	567 tons	$6.00/ton	$ 3,402.00
Vent	2	$200/each	$ 400.00
Liner - PVC Membrane	45,000 s.f.	$0.35/s.f.	$ 15,750.00
Topsoil	833 c.y.	$9.00/c.y.	$ 7,497.00
Seed, Fertilize and Mulch	5,000 s.y.	$0.32/s.y.	$ 1,600.00
Engineering		Lump Sum	$ 25,000.00
		Subtotal	$1,403,236.45
		10% Contingency	$ 140,323.65
		TOTAL	$1,543,560.10[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

WARZYN ENGINEERING INC

[WEI 8-56]
pag

OMC-WAUKEGAN
OMC SITE - OPTION 4
SITE PREPARATION
(Cont'd)

Item	Quantity	Unit Cost	Cost
Engineering		Lump Sum	$ 150,000.00
		Subtotal	$5,429,460.34
		10% Contingency	$ 542,946.03
		TOTAL	$5,972,406.37[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

[WEI 8-55]
pag

WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 4
SITE PREPARATION

Item	Quantity	Unit Cost	Cost
Excavation	630,224 c.y.	$1.00/c.y.	$ 630,224.00
Recompacted Clay	284,135 c.y.	$9.00/c.y.	$2,557,215.00
Filter Cloth	248,184 s.f.	$0.11/s.f.	$ 27,300.24
Granular Material	17,888 c.y.	$2.50/c.y.	$ 44,720.00
Liner - PVC Membrane	651,436 s.f.	$0.35/s.f.	$ 228,002.60
Leachate Collection System			
Pipe	3,712 l.f.	$7.50/l.f.	$ 27,840.00
Manhole	($595 + (29.5'-8')	$78 + $160) 8[1]	$ 19,456.00
Underdrain System			
Pipe	3,355 l.f.	$7.50/l.f.	$ 25,162.50
Manhole	($595 + (35.5'-8')	$78 + $160) 6[1]	$ 17,400.00
Slurry Trench - In-situ Disposal	52,500 s.f.	$3.50/s.f.	$ 183,750.00
Slurry Trench - Dewatering	140,000 s.f.	$3.50/s.f.	$ 490,000.00
On-site Disposal of Excavated Material	636,870 c.y.	$1.50/c.y.	$ 955,305.00
Leachate Collection System In-situ Disposal			
Pipe	840 l.f.	$9.50/l.f.	$ 7,980.00
Manhole	1	$595 + $160[1]	$ 755.00
Drainage Swale	4,100 l.f.	$3.50/l.f.	$ 14,350.00
Relocate Utilities		Lump Sum	$ 50,000.00

WARZYN ENGINEERING INC

APPENDIX D

OMC SITE - OPTION 4

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 3
SITE CLOSURE

Item	Quantity	Unit Cost	Cost
Final Cover Placement	77,916 c.y.	$9.00/c.y.	$ 701,244.00
Gas Venting			
Gravel	2,484 tons	$6.00/ton	$ 14,904.00
Vents	6	$200/each	$ 1,200.00
Liner - PVC Membrane	589,050 s.f.	$0.35/s.f.	$ 206,167.50
Bituminous Pavement	692,859 s.f.	$0.55/s.f.	$ 381,072.45
Engineering		Lump Sum	$ 25,000.00
		Subtotal	$1,329,587.95
		10% Contingency	$ 132,958.80
		TOTAL	$1,462,546.75[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

[WEI 8-54]
pag

WARZYN ENGINEERING INC

OMC-WAUKEGAN
OMC SITE - OPTION 3
SITE PREPARATION

Item	Quantity	Unit Cost	Cost
Excavation	621,013 c.y.	$1.00/c.y.	$ 621,013.00
Slurry Trench - Dewatering	154,000 s.f.	$3.50/s.f.	$ 539,000.00
Clay Liner	288,156 c.y.	$9.00/c.y.	$2,593,404.00
Granular Blankets	13,046 c.y.	$2.50/c.y.	$ 32,615.00
Filter Cloth	208,104 s.f.	$0.11/s.f.	$ 22,891.44
PVC Membrane - Liner	752,759 s.f.	$0.35/s.f.	$ 263,465.65
Leachate Collection System			
Pipe	3,568 l.f.	$7.50/l.f.	$ 26,760.00
Manhole	($595 + (37'- 8')$78 + $160) 8[1]		$ 24,136.00
Underdrain System			
Pipe	3,235 l.f.	$7.50/l.f.	$ 24,262.50
Manhole	($595 + (39.5'-8')$78 + $160) 6[1]		$ 19,272.00
On-site Disposal of Excavated Material	625,609 c.y.	$1.50/c.y.	$ 938,413.50
Drainage Swale	4,100 l.f.	$3.50/l.f.	$ 14,350.00
Relocate Utilities		Lump Sum	$ 50,000.00
Engineering		Lump Sum	$ 150,000.00
		Subtotal	$5,319,583.09
		10% Contingency	$ 531,958.31
		TOTAL	$5,851,541.40[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

[WEI 8-53]
pag

APPENDIX C

OMC SITE - OPTION 3

WARZYN
ENGINEERING INC

OMC-WAUKEGAN
CECOS - WILLIAMSBURG - OPTION 2
SITE CLOSURE

Costs

Item	Quantity	Unit Cost	Cost
Final Cover Placement	83,890 c.y.	$1.30/c.y.	$109,057.00
Topsoil Placement	40,267 s.y.	$0.30/s.y.	$ 12,080.10
Seed, Fertilize & Mulch	40,267 s.y.	$0.32/s.y.	$ 12,885.44
PVC Liner	380,524 s.f.	$0.35/s.f.	$133,183.40
Gas Venting			
Gravel	813 tons	$6.00/ton	$ 4,878.00
Vents	5	$200/each	$ 1,000.00
Engineering		Lump Sum	$ 20,000.00
		Subtotal	$293,083.94
		10% Contingency	$ 29,308.39
		TOTAL	$322,392.33[1]

Note:

1. These quantities and costs are based on present information of site conditions and should be considered approximate.

2. See Appendix H for Site Operation and Long-Term Care Costs.

[WEI 8-52]
pag

WARZYN ENGINEERING INC

C 9400

OMC-WAUKEGAN
CECOS - WILLIAMSBURG - OPTION 2
SITE PREPARATION

Costs

Item	Quantity	Unit Cost	Cost
Excavation	489,032 c.y.	$1.00/c.y.	$ 489,032.00
Strip Topsoil	7,420 c.y.	$0.85/c.y.	$ 6,307.00
Recompact Clay Liner	137,411 c.y.	$1.50/c.y.	$ 206,116.50
Granular Blankets	7,905 c.y.	$7.50/c.y.	$ 59,287.50
Liner- PVC Membrane	445,213 s.f.	$0.35/s.f.	$ 155,824.55
Leachate Collection System			
Pipe	2,260 l.f.	$7.50/l.f.	$ 16,950.00
Manhole	6 ($595 + (42'- 8')$78 + $160)[1]		$ 20,442.00
Underdrain System			
Pipe	1,350 l.f.	$7.50/l.f.	$ 10,125.00
Manhole	4($595 + (60.5'- 8')$78 + $160)[1]		$ 19,400.00
Drainage Swale	2,448 l.f.	$3.50/l.f.	$ 8,568.00
Filter Cloth	213,444 s.f.	$0.11/s.f.	$ 23,478.84
Engineering		Lump Sum	$ 40,000.00
		Subtotal	$1,055,531.39
		10% Contingency	$ 105,553.14
		TOTAL	$1,161,084.53[2]

Notes:

1. Manhole Construction Costs
   8' Deep = $595
   Beyond 8' = $78/V.L.F.
   Casting = $160

2. These quantities and costs are based on present information of site conditions and should be considered approximate.

WARZYN ENGINEERING INC

[WEI 8-51]
pag

POCKET INSERT 2: NORTH DITCH CONTAMINATION

FINAL SITE SELECTION AND EVALUATIO
FOR A HAZARDOUS WASTE DISPOSAL SIT

BROWNING FERRIS INDUSTRIES SITE – ZION, ILLINO
C.E.R.- CECOS SITE – WILLIAMSBURG, OH
O.M.C. PROPERTY – WAUKEGAN, ILLINO

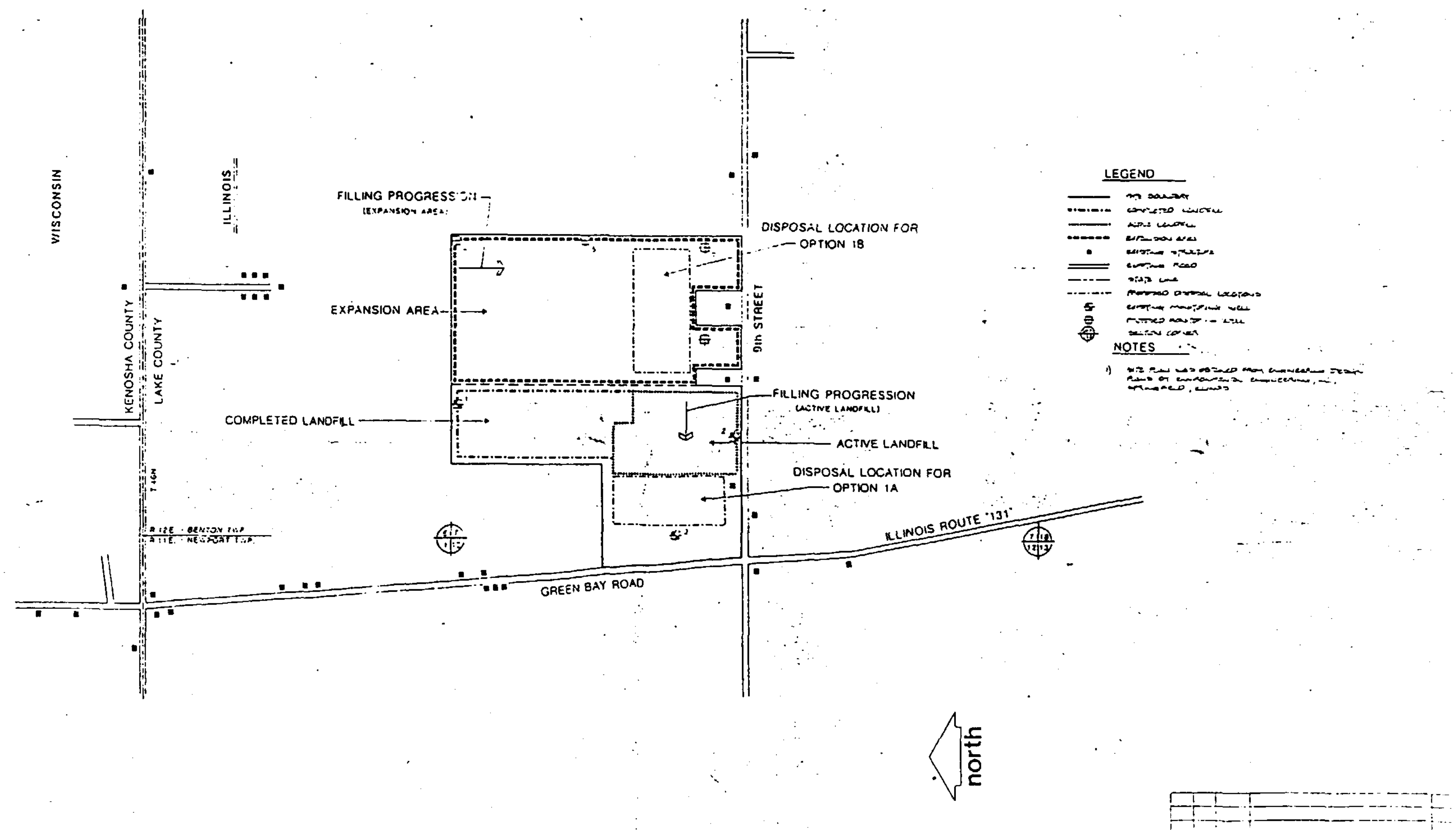
LIST OF DRAWINGS

SHEET NO.	TITLE	DRAWING NO.
1	BFI SITE PLAN	C9400-3
2	BFI SITE-OPTION 1A	C9400-4
3	BFI SITE-OPTION 1B	C9400-5
4	CECOS-WILLIAMSBURG SITE PLAN	C9400-6
5	CECOS-WILLIAMSBURG - OPTION 2	C9400-7
6	OMC SITE PLAN	C9400-14
7	OMC SITE - OPTION 3	C9400-8
8	OMC SITE - OPTION 4	C9400-9
9	OMC SITE - OPTION 5A	C9400-10
10	OMC SITE - OPTION 5B	C9400-11
11	OMC SITE - OPTION 6	C9400-12
12	OMC SITE - OPTION 7	C9400-13

PREPARED BY:
WARZYN ENGINEERING INC.
CONSULTING ENGINEERS
MADISON, WISCONSIN

PREPARED FOR:
MASON & HANGER
SILAS MASON CO., INC.

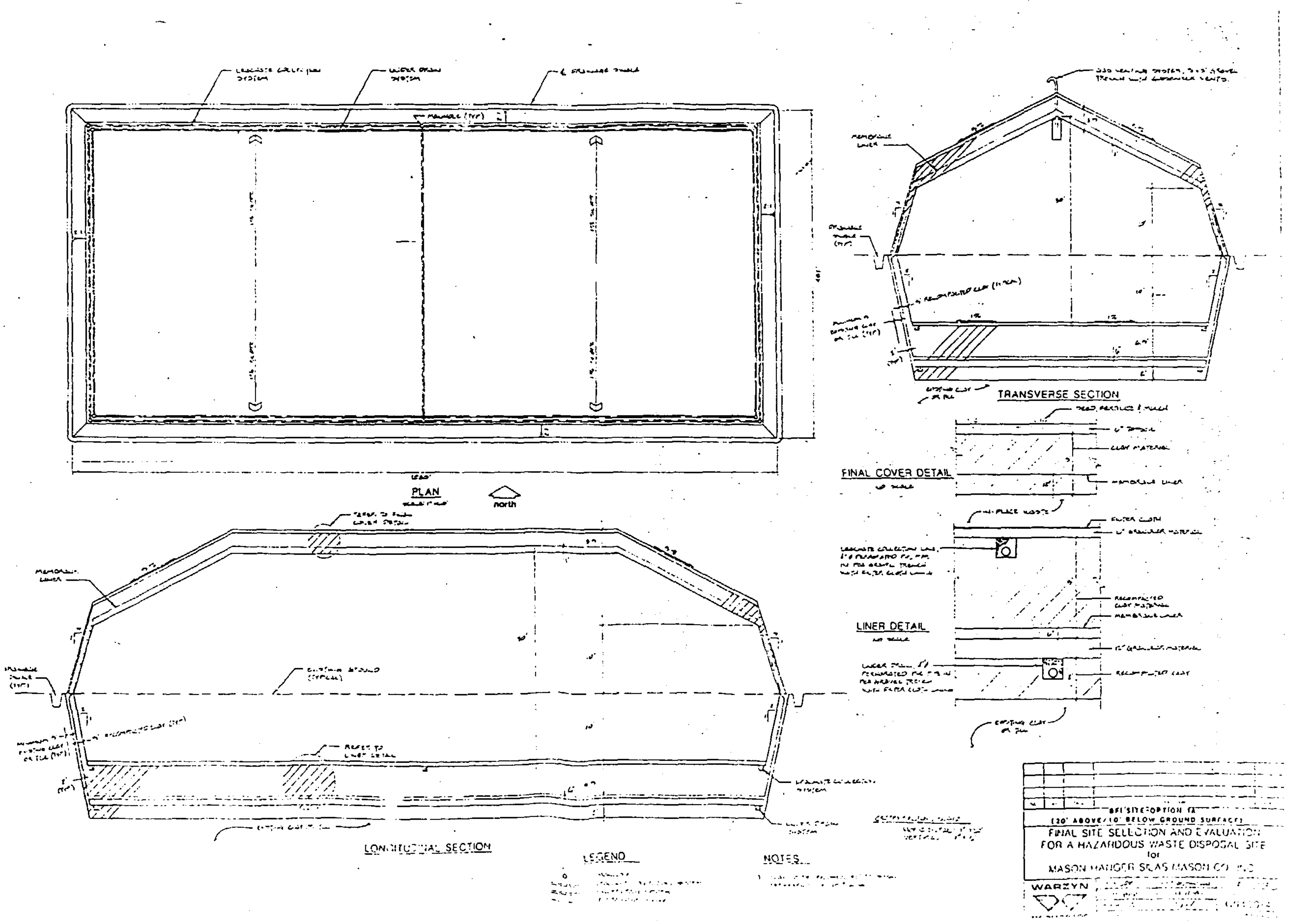
DEC. 12. 1980 C9400-1



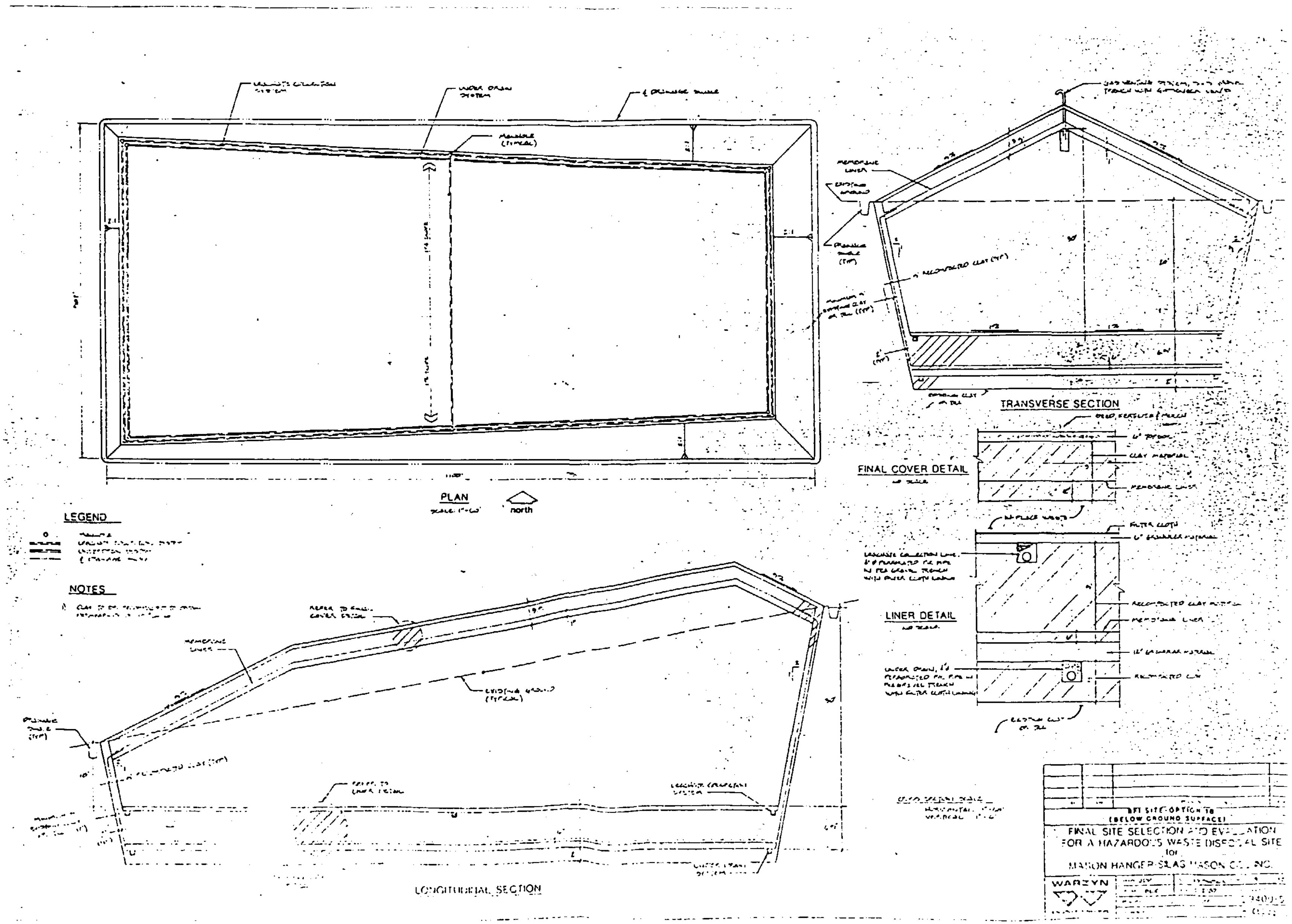
BFI SITE PLAN

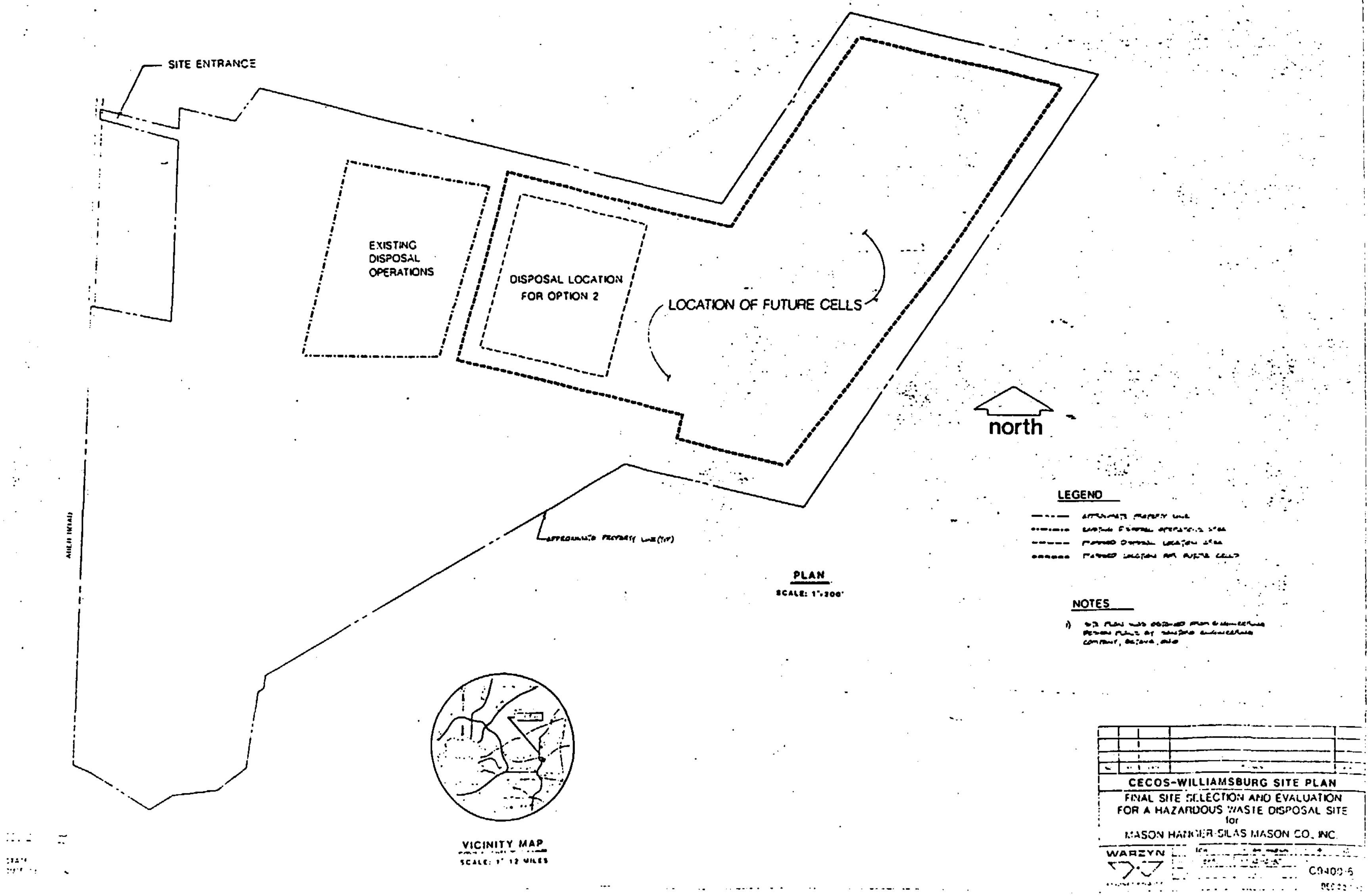
FINAL SITE SELECTION AND EVALUATION FOR A HAZARDOUS WASTE DISPOSAL SITE for MASON HANGER SILAS MASON CO. INC

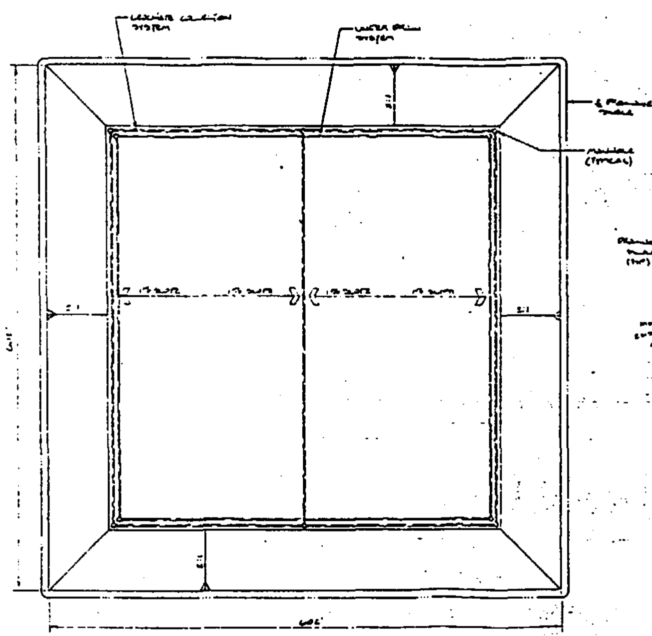
WARZYN



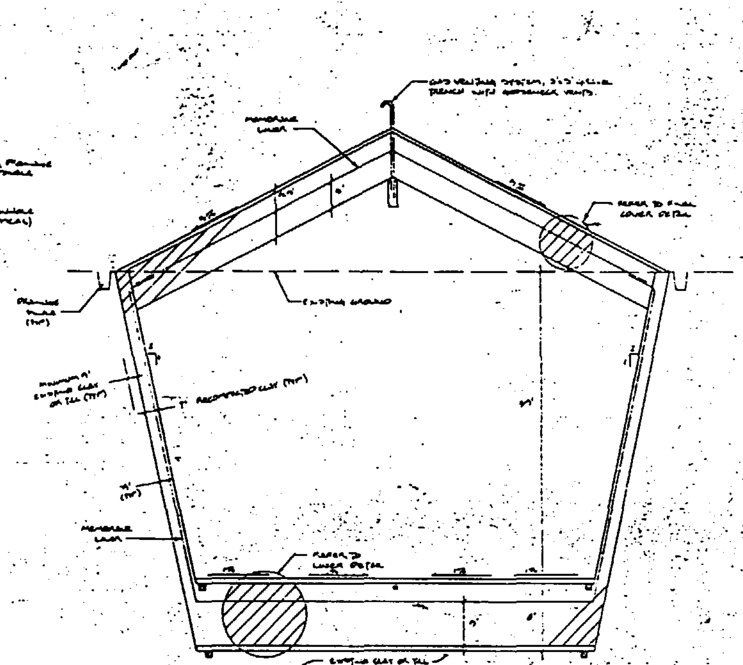
PLAN
north
TRANSVERSE SECTION
FINAL COVER DETAIL
LINER DETAIL
LONGITUDINAL SECTION
LEGEND
NOTES
BFI SITE OPTION IA
(30' ABOVE/10' BELOW GROUND SURFACE)
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER SILAS MASON CO. INC.
WARZYN


PLAN
north
LEGEND
NOTES
TRANSVERSE SECTION
FINAL COVER DETAIL
LINER DETAIL
LONGITUDINAL SECTION
WARZYN
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO., INC.

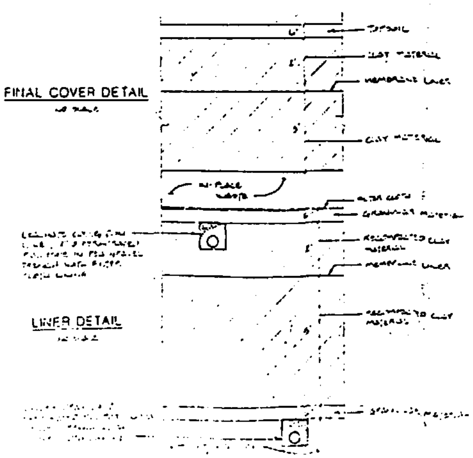

SITE ENTRANCE
EXISTING DISPOSAL OPERATIONS
DISPOSAL LOCATION FOR OPTION 2
LOCATION OF FUTURE CELLS
north
LEGEND
PLAN
NOTES
VICINITY MAP
SCALE: 1" 12 MILES
CECOS-WILLIAMSBURG SITE PLAN
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO., INC.
WARZYN



PLAN



TRANSVERSE SECTION



FINAL COVER DETAIL

LINER DETAIL

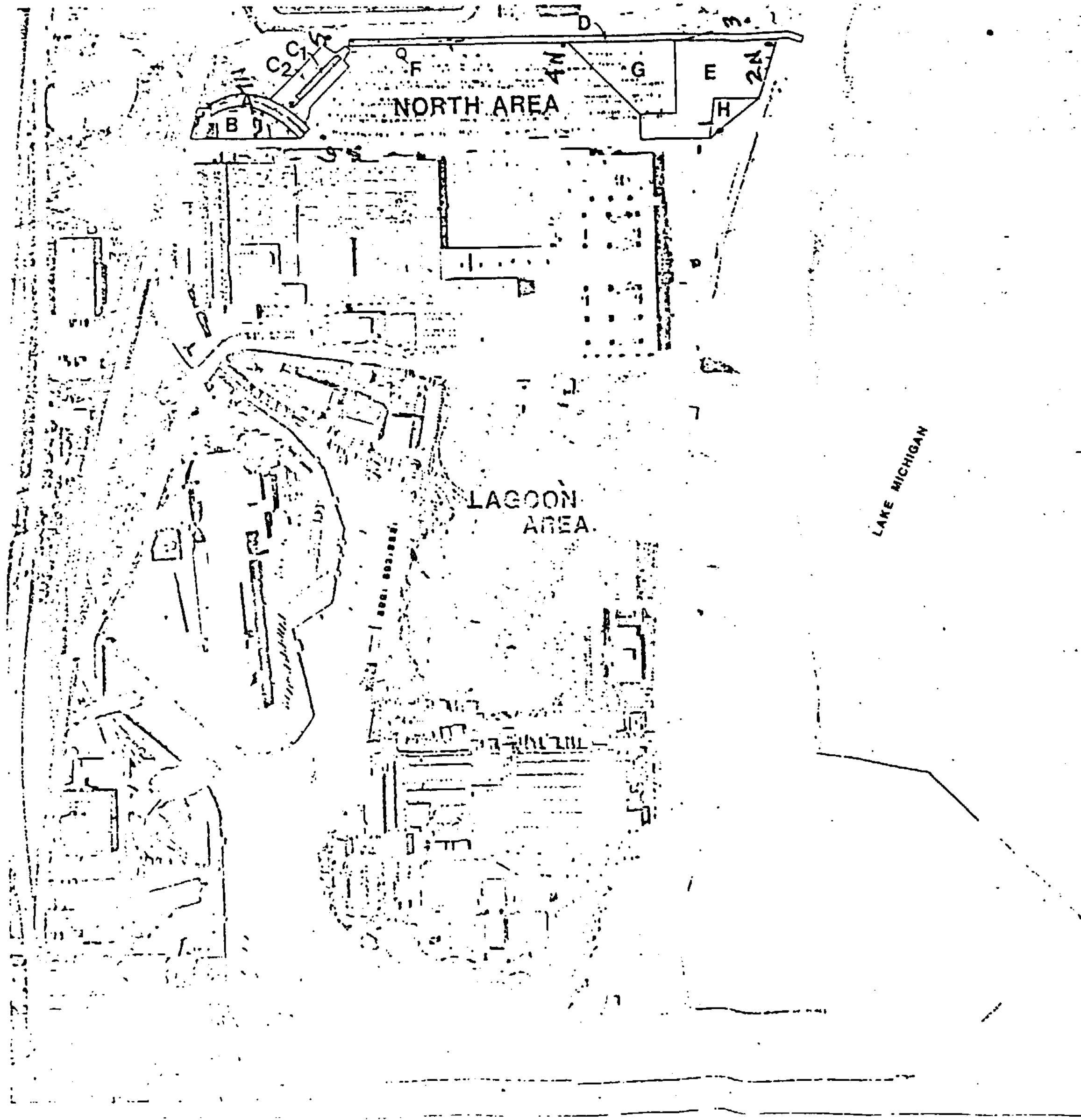
LEGEND

NOTES

CECOS-WILLIAMSBURG-OPTION 2

FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO., INC.

WARZYN



LOCATION OF CONTAMINATED NORTH AREAS

LEGEND	LOCATION	AREA/DIMENSION	DEPTH, FT	CUBIC YARDS
A	CRESCENT SHAPED LAGOON	60 FT x 520 FT	25	28,900
B	OIL STORAGE AREA	21,000 FT²	3	2,500
C_1	OVAL SHAPED LAGOON	7500 FT²	16	4,400
C_2	AREA SURROUNDING LAGOON	34,500 FT²	8	10,200
D	NORTH DITCH	25 FT x 1500 FT	2	3,500
E	PARKING LOT	112,000 FT² 20,000 FT²	12 2	49,800 1,500

ADDITIONAL AREAS

F	PARKING LOT	20 FT RADIUS	5	200
G	PARKING LOT	75,600 FT²	5	14,000
H	PARKING LOT	15,000 FT²	5	2,800

NOTES

1) [illegible]

north

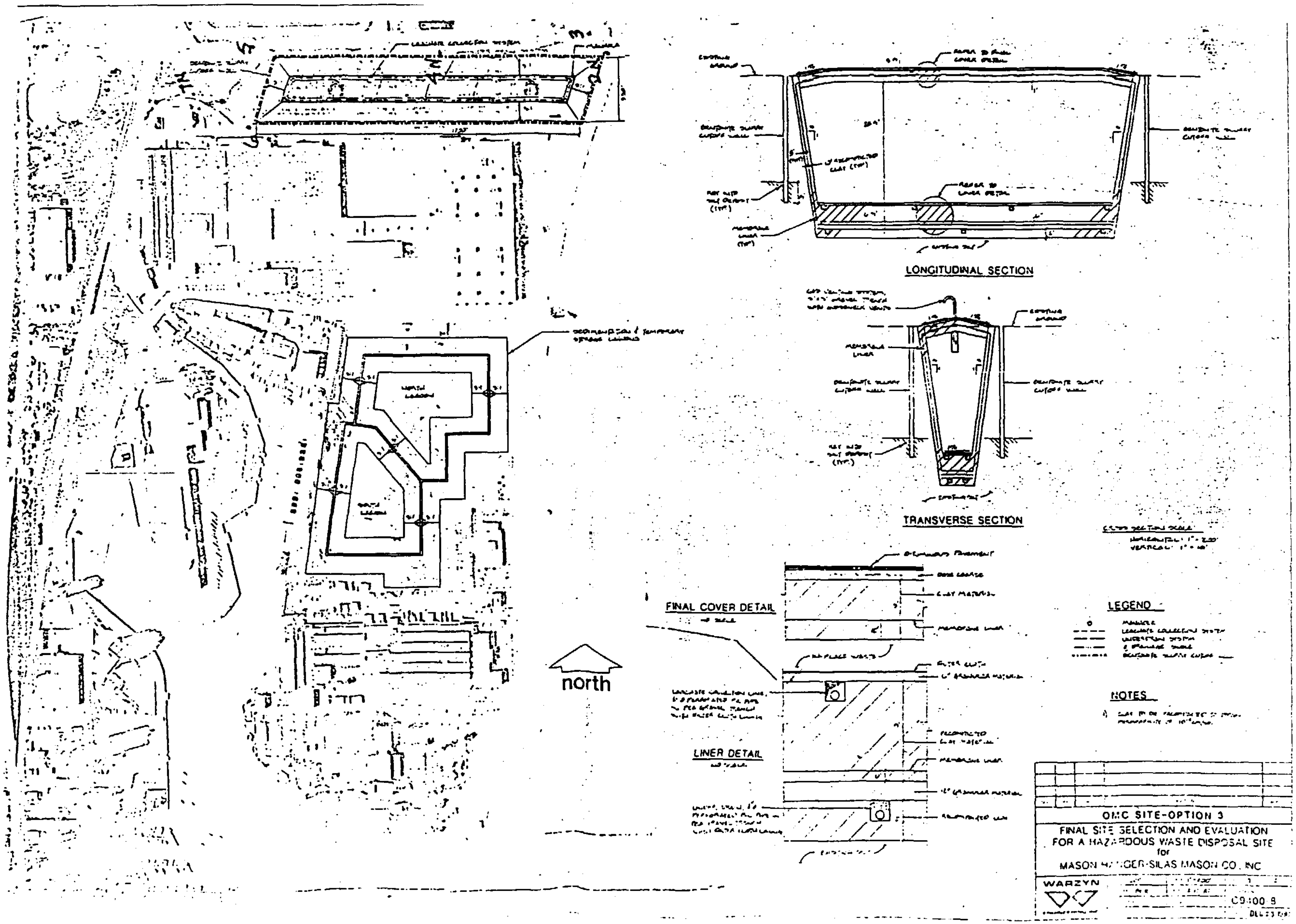
OMC-SITE PLAN

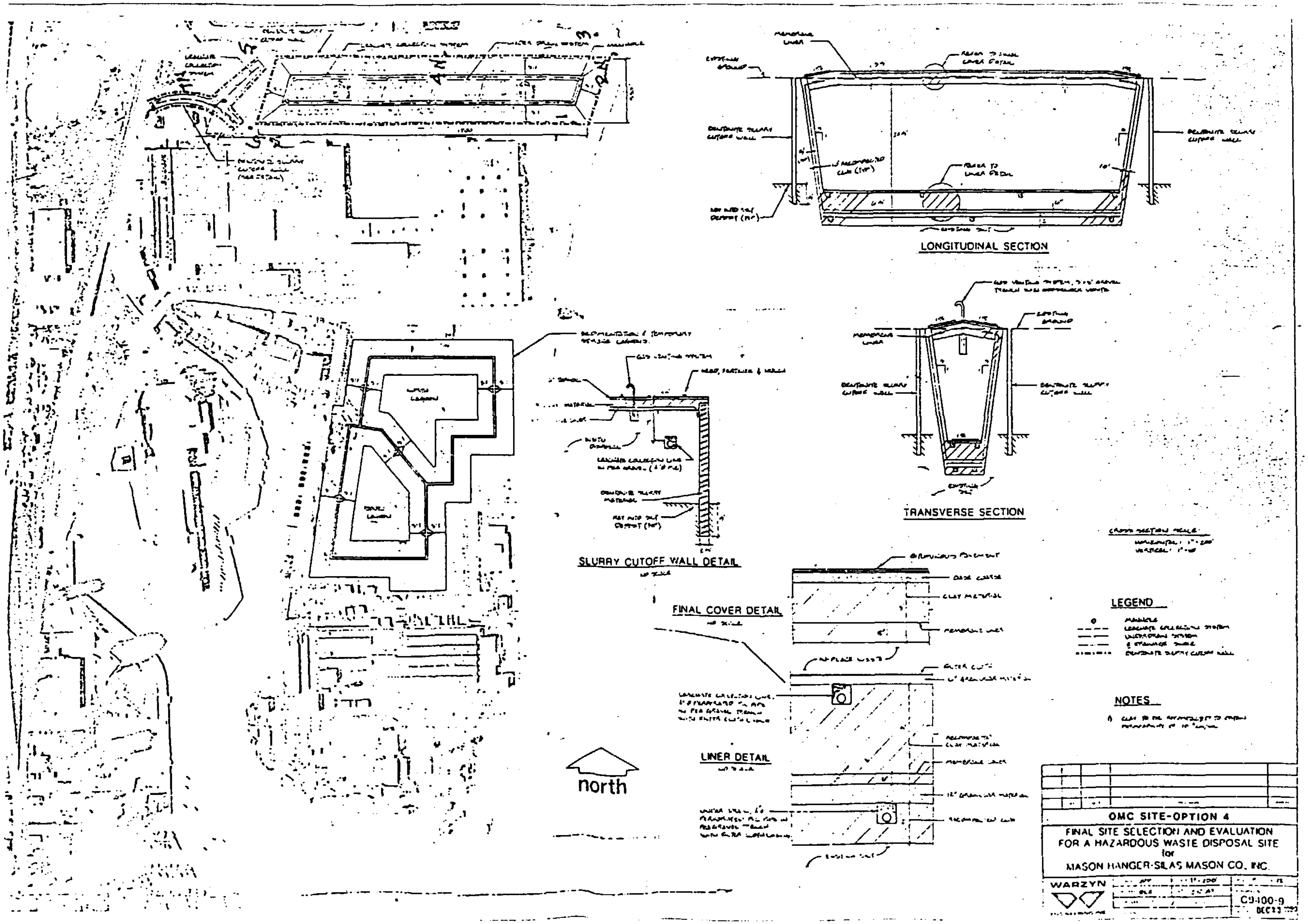
FINAL SITE SELECTION AND EVALUATION FOR A HAZARDOUS WASTE DISPOSAL SITE

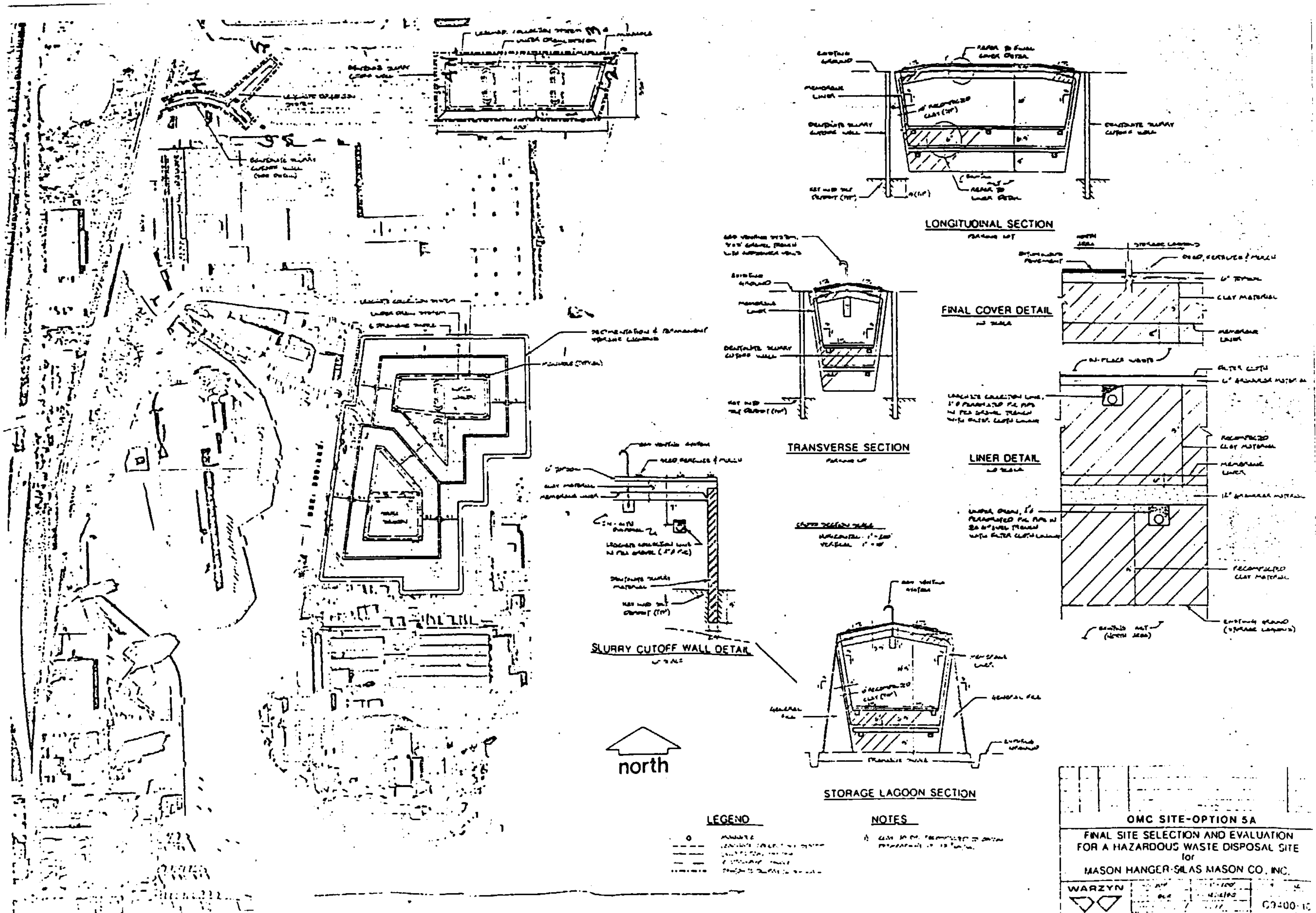
for

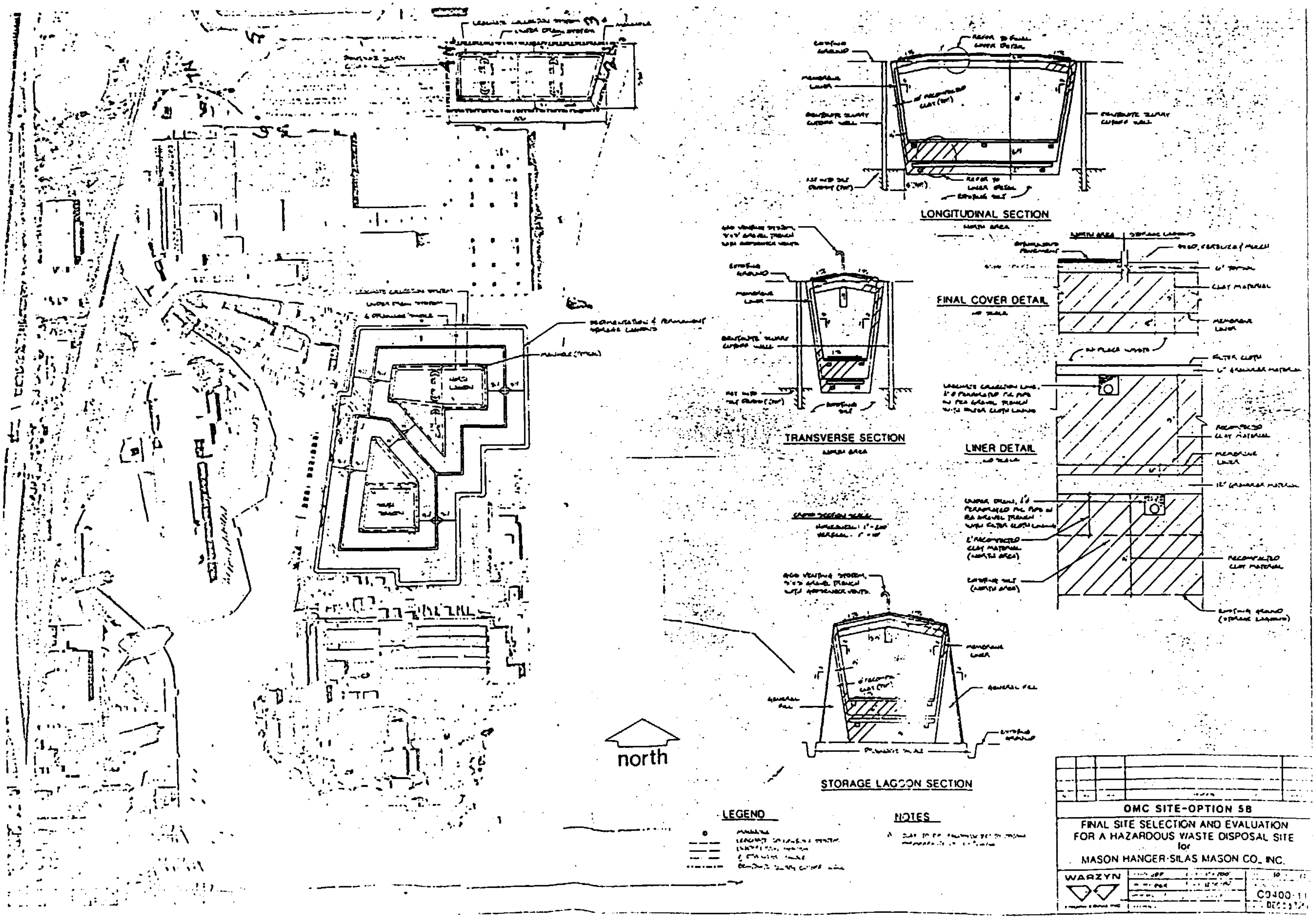
MASON HANGER SILAS MASON CO. INC.

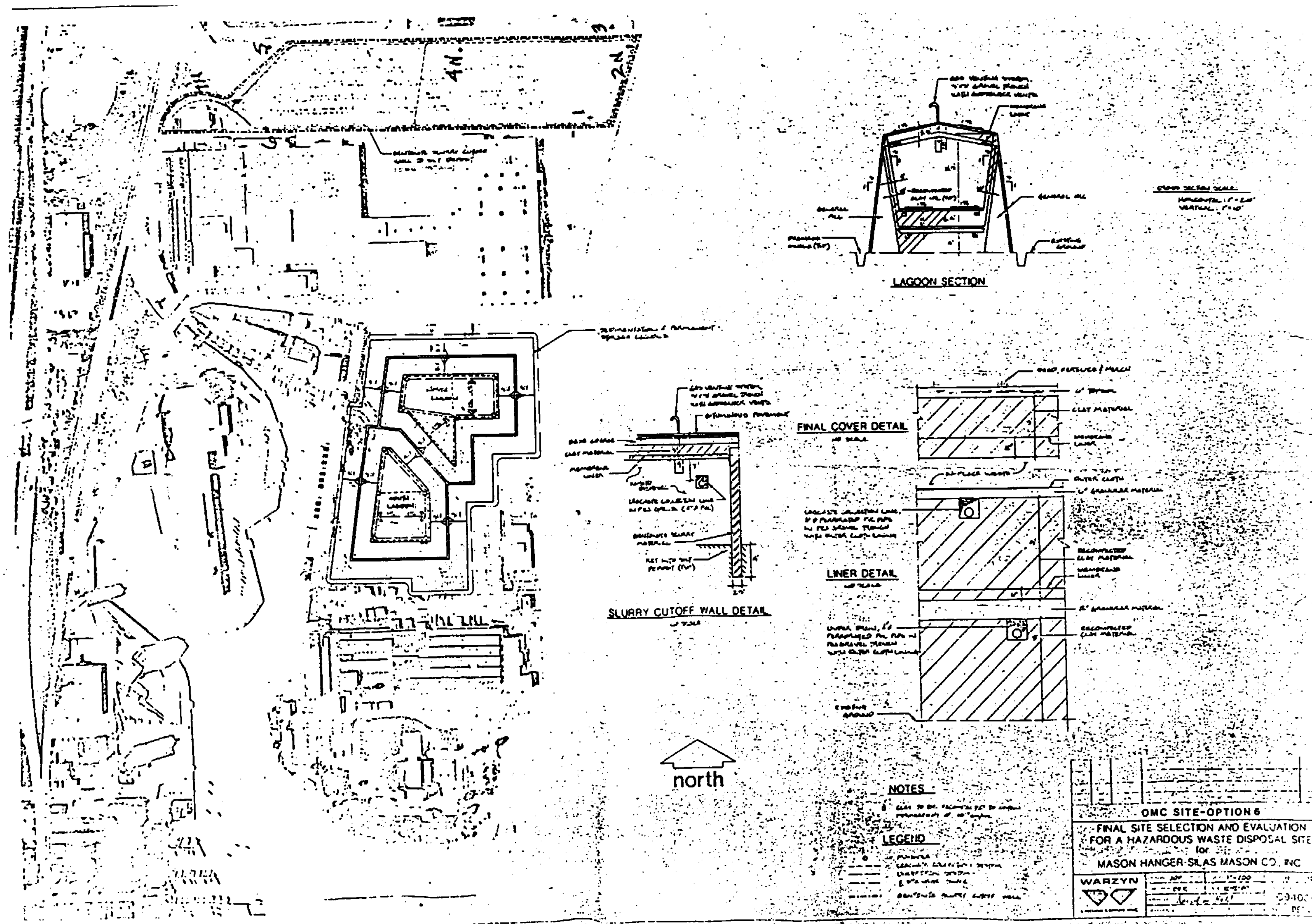
WARZYN


LONGITUDINAL SECTION
TRANSVERSE SECTION
FINAL COVER DETAIL
LINER DETAIL
LEGEND
NOTES
north
OMC SITE-OPTION 3
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO. INC
WARZYN

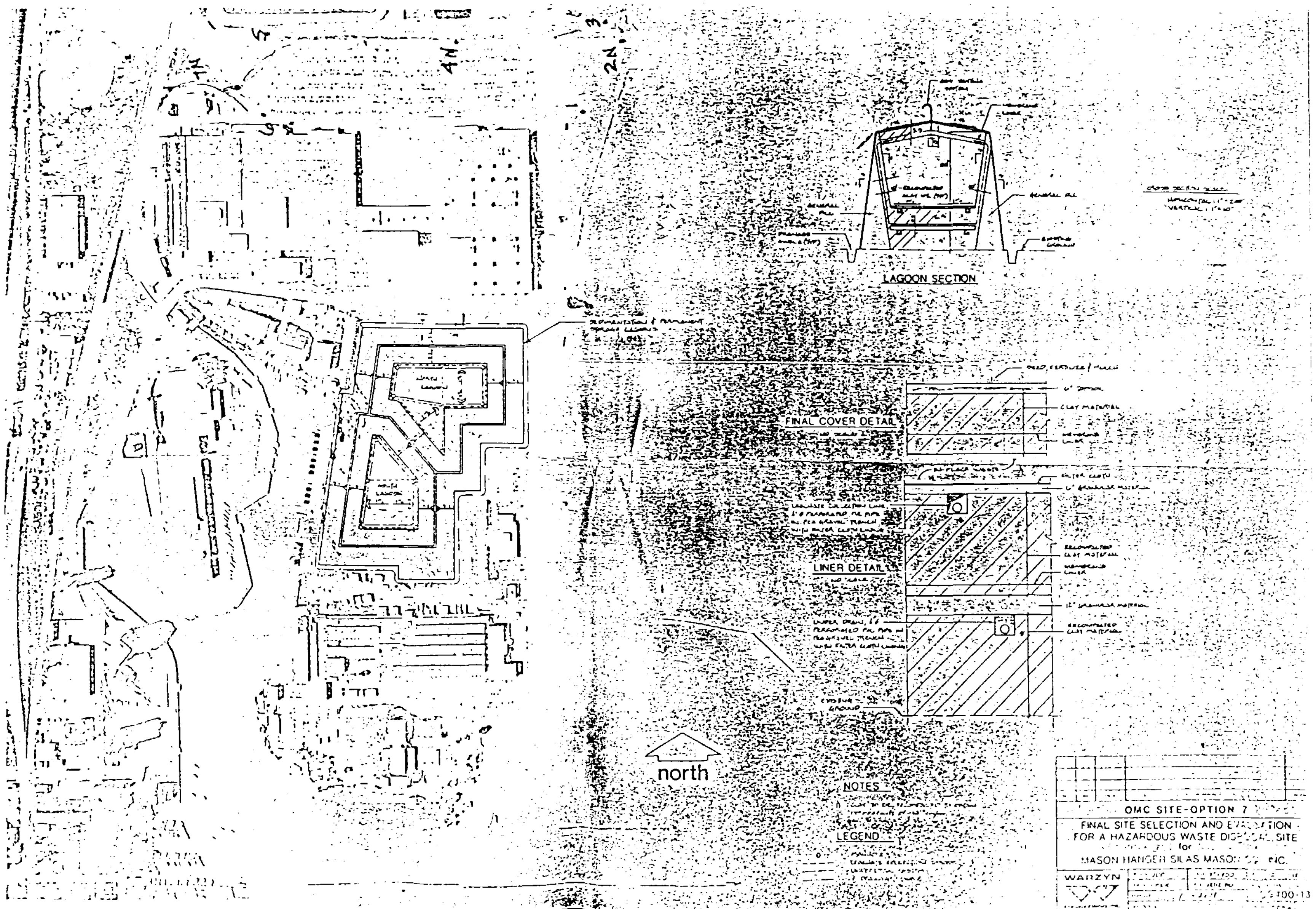

LONGITUDINAL SECTION
TRANSVERSE SECTION
SLURRY CUTOFF WALL DETAIL
FINAL COVER DETAIL
LINER DETAIL
LEGEND
NOTES
north
OMC SITE-OPTION 4
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO. INC.
WARZYN

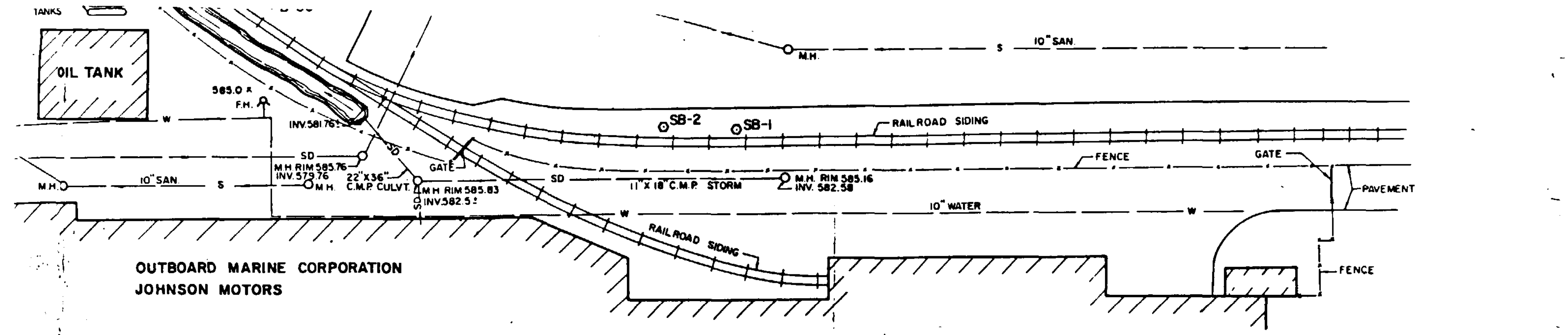

LONGITUDINAL SECTION
TRANSVERSE SECTION
FINAL COVER DETAIL
LINER DETAIL
SLURRY CUTOFF WALL DETAIL
STORAGE LAGOON SECTION
north
LEGEND
NOTES
OMC SITE-OPTION 5A
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO. INC.
WARZYN


LONGITUDINAL SECTION
TRANSVERSE SECTION
FINAL COVER DETAIL
LINER DETAIL
STORAGE LAGOON SECTION
north
LEGEND
NOTES
OMC SITE-OPTION 5B
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO., INC.
WARZYN



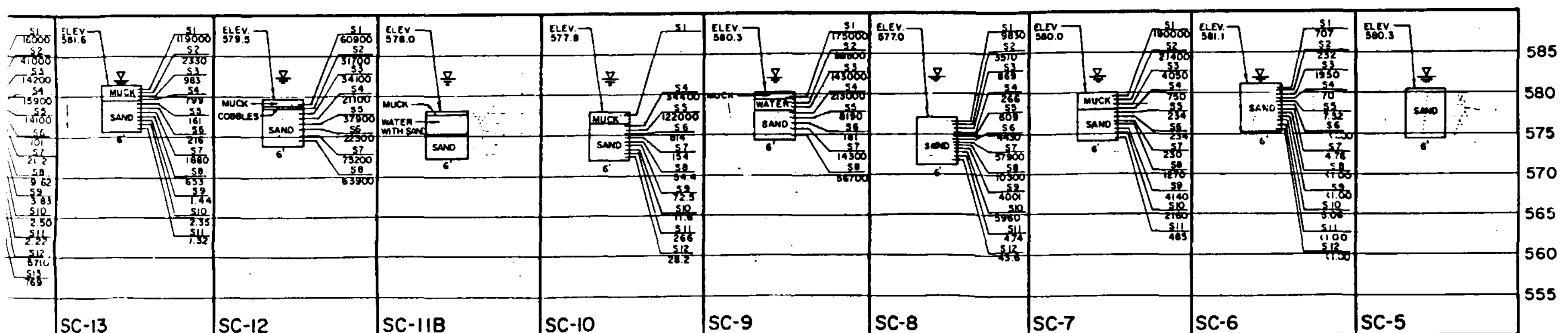
4N
2N
LAGOON SECTION
FINAL COVER DETAIL
LINER DETAIL
SLURRY CUTOFF WALL DETAIL
north
NOTES
LEGEND
OMC SITE-OPTION 6
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER-SILAS MASON CO. INC
WARZYN

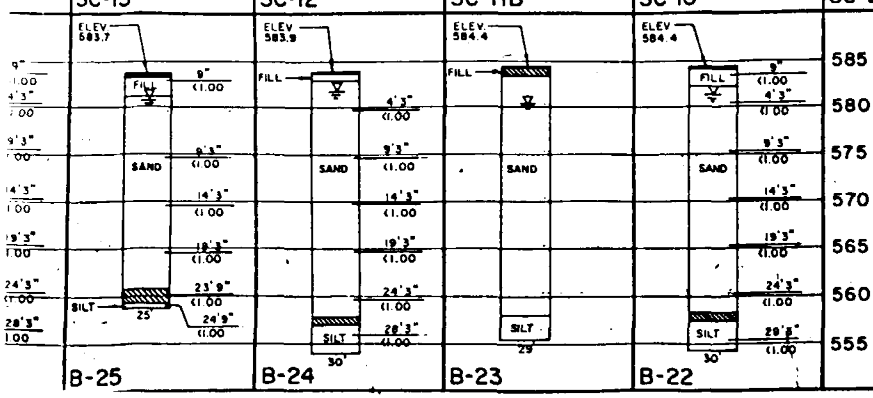

LAGOON SECTION
FINAL COVER DETAIL
LINER DETAIL
north
NOTES
LEGEND
OMC SITE-OPTION 7
FINAL SITE SELECTION AND EVALUATION
FOR A HAZARDOUS WASTE DISPOSAL SITE
for
MASON HANGER SILAS MASON CO., INC.
WARZYN



PROFILE
1" = 10' VERT.
NONE HORIZ.

PLAN
SCALE: 1" = 40'





MASON & HANGER · SILAS MASON CO., INC.
ARCHITECTS ENGINEERS
LEXINGTON KENTUCKY

SUBMITTED
DATE
RECOMMENDED
DATE
APPROVED
DATE

NO.	DATE	REVISIONS	BY	CK	A·E

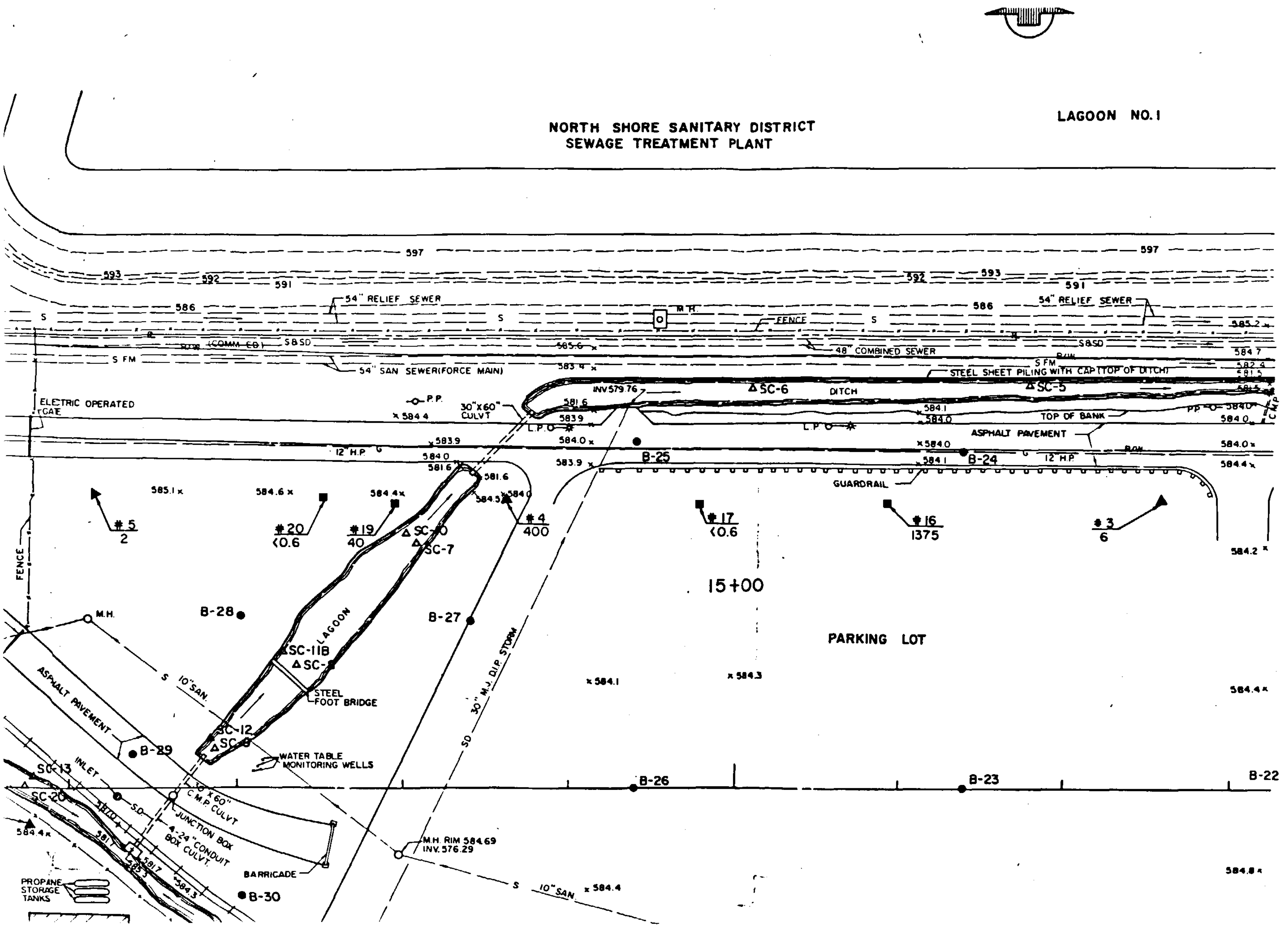
DRAWN
CHECKED
ENGR
APPROVED BY DATE

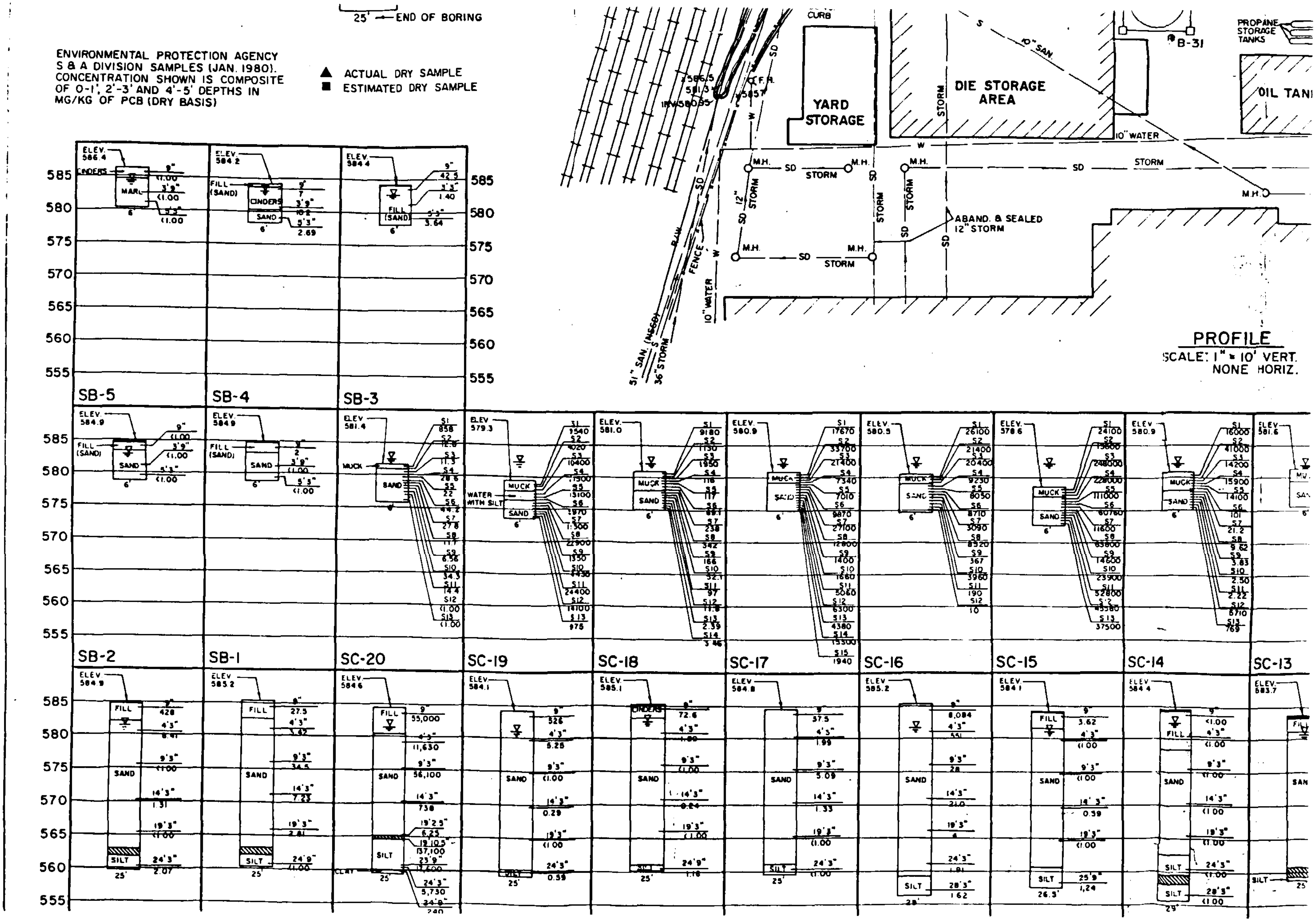
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

OUTBOARD MARINE CORPORATION WAUKEGAN, ILLINOIS

SUBSURFACE INVESTIGATION
NORTH DITCH AREA

CONT. NO.	JOB NO.	SCALE:	SHEET NO	DRAWING NO	REV
		AS SHOWN	1 OF 2		


NORTH SHORE SANITARY DISTRICT
SEWAGE TREATMENT PLANT
LAGOON NO. 1
54" RELIEF SEWER
FENCE
48" COMBINED SEWER
54" SAN SEWER (FORCE MAIN)
STEEL SHEET PILING WITH CAP (TOP OF DITCH)
DITCH
TOP OF BANK
ASPHALT PAVEMENT
GUARDRAIL
ELECTRIC OPERATED GATE
30"x60" CULVT
INV 579.76
12" H.P.
SC-5
SC-6
SC-7
SC-10
SC-11B
SC-12
SC-13
SC-20
B-22
B-23
B-24
B-25
B-26
B-27
B-28
B-29
B-30
#5 2
#20 <0.6
#19 40
#4 400
#17 <0.6
#16 1375
#3 6
15+00
PARKING LOT
LAGOON
STEEL FOOT BRIDGE
WATER TABLE MONITORING WELLS
30" M.J. D.I.P. STORM
10" SAN.
M.H. RIM 584.69
INV. 576.29
BARRICADE
JUNCTION BOX
4-24" CONDUIT BOX CULVT.
30"x60" C.M.P. CULVT
INLET
PROPANE STORAGE TANKS
M.H.
P.P.
L.P.



ENVIRONMENTAL PROTECTION AGENCY S & A DIVISION SAMPLES (JAN. 1980). CONCENTRATION SHOWN IS COMPOSITE OF 0-1', 2'-3' AND 4'-5' DEPTHS IN MG/KG OF PCB (DRY BASIS)
25' — END OF BORING
ACTUAL DRY SAMPLE
ESTIMATED DRY SAMPLE
CURB
YARD STORAGE
DIE STORAGE AREA
B-31
PROPANE STORAGE TANKS
OIL TANK
10" SAN
10" WATER
M.H.
SD
STORM
12" STORM
ABAND. & SEALED 12" STORM
F.H.
FENCE
R/W
10" WATER
51" SAN. (MSD)
36" STORM
PROFILE
SCALE: 1" = 10' VERT. NONE HORIZ.
585
580
575
570
565
560
555
SB-5
SB-4
SB-3
SB-2
SB-1
SC-20
SC-19
SC-18
SC-17
SC-16
SC-15
SC-14
SC-13
ELEV. 586.4
ELEV. 584.2
ELEV. 584.4
ELEV. 584.9
ELEV. 584.9
ELEV. 581.4
ELEV. 579.3
ELEV. 581.0
ELEV. 580.9
ELEV. 580.5
ELEV. 578.6
ELEV. 580.9
ELEV. 581.6
ELEV. 584.9
ELEV. 585.2
ELEV. 584.6
ELEV. 584.1
ELEV. 585.1
ELEV. 584.8
ELEV. 585.2
ELEV. 584.1
ELEV. 584.4
ELEV. 583.7
CINDERS
MARL
FILL (SAND)
SAND
MUCK
WATER WITH SILT
FILL
SILT
CLAY

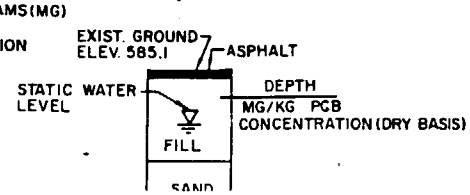
7 6 5

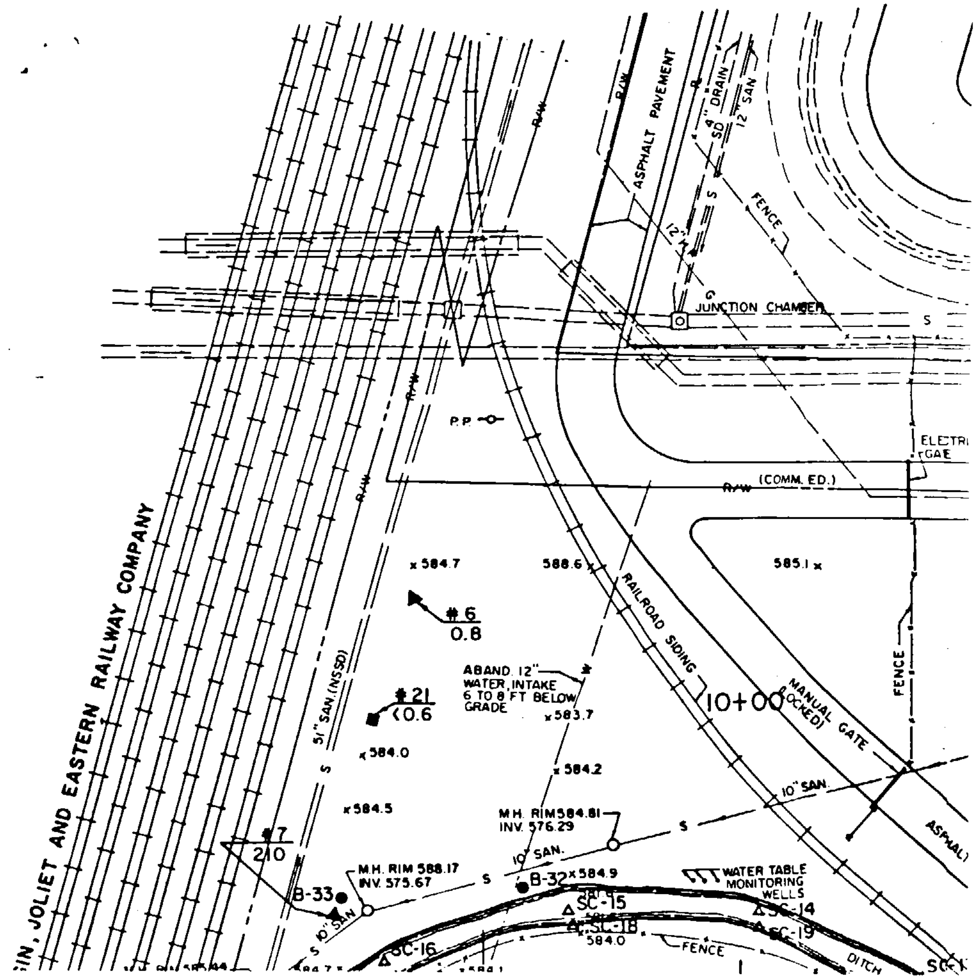
NOTE:

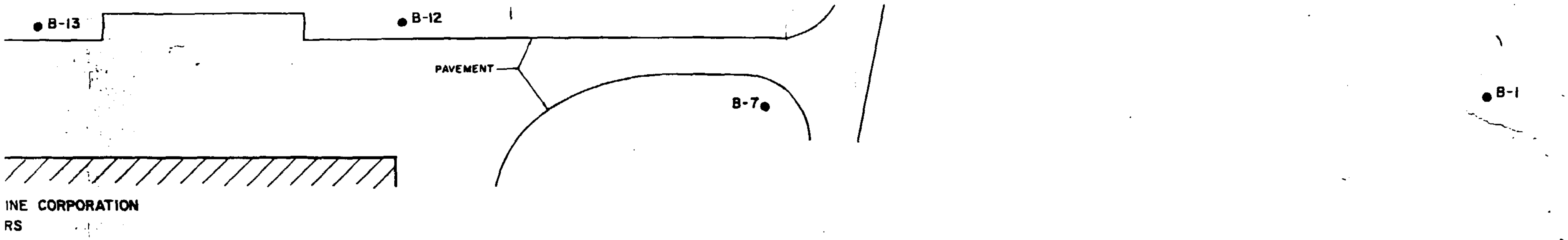
1. ELEVATIONS ARE BASED ON USC & GS MEAN SEA LEVEL DATUM. (1929 GENERAL ADJUSTMENT)
2. BENCH MARK - TOP OF NORTHWEST BOLT OF VALVE AT THE WEST END OF THE EXISTING FINAL SEDIMENTATION TANK NO.1 LOCATED IN THE NORTH SHORE SANITARY DISTRICT SEWAGE TREATMENT PLANT ELEV. 591.86.

LEGEND

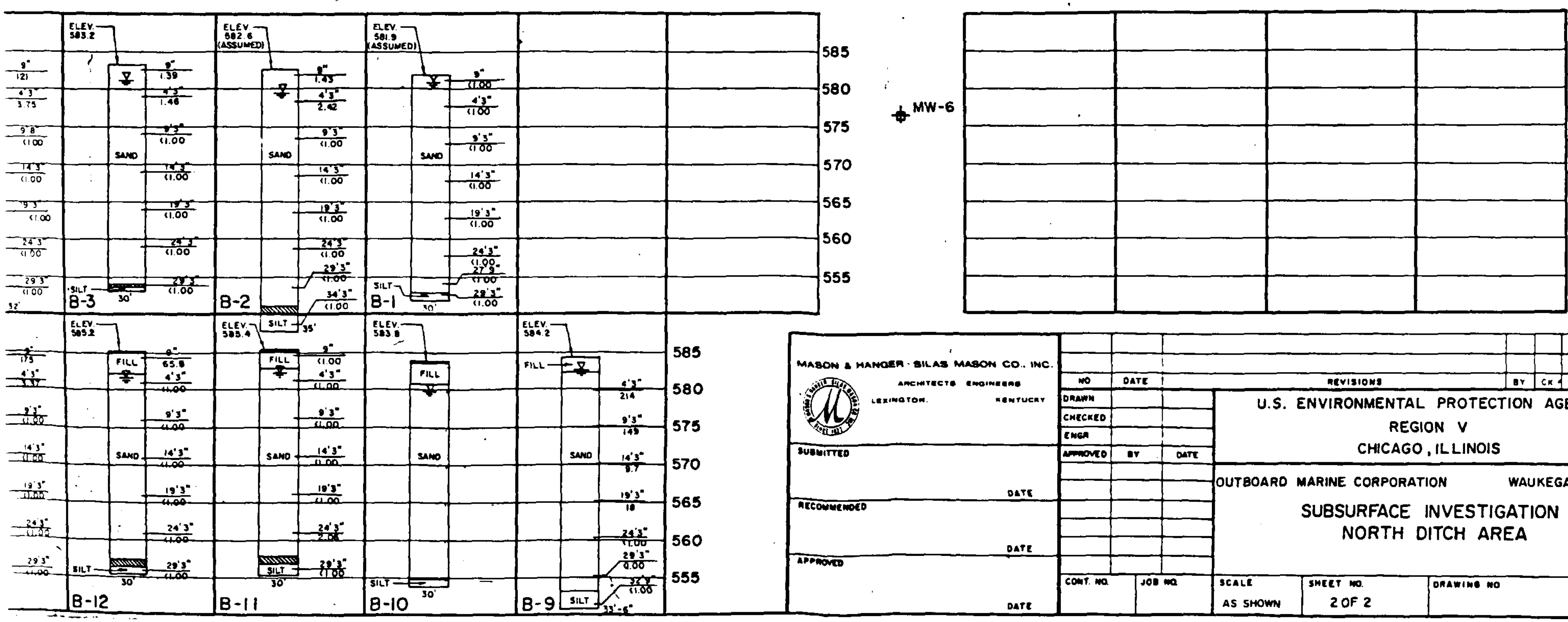
CENTERLINE	
ELEVATION	x 584.81
MANHOLE	O M.H.
DROP INLET	● D.I.
STORM DRAIN	SD
SANITARY SEWER	S
WATER LINE	W
GAS LINE	G
PAVEMENT	
RAILROAD	
FENCE	
GATE	
FIRE HYDRANT	F.H.
RIGHT OF WAY OR PROPERTY LINE	
STRUCTURE	
DITCH	
FLOW LINE DIRECTION	
POWER POLE	P.P.
LIGHT POLE	L.P.
WATER TABLE MONITORING WELLS	ooo
USC & GS GAGING STATION	
BORING - 25' TO 35' DEEP	● B-34
SEDIMENT CORE - 6' DEEP	△ SC-20
SHALLOW BORING - 6' DEEP	SB-1
GROUNDWATER OBSERVATION WELL	MW-4
SAMPLE DEPTHS AND MILLIGRAMS(MG) PER KILOGRAM(KG) OF PCB CONTAMINATION CONCENTRATION IN SAMPLE.	







PLAN
SCALE: 1" = 40'



MASON & HANGER - SILAS MASON CO., INC.
ARCHITECTS ENGINEERS
LEXINGTON, KENTUCKY

NO	DATE	REVISIONS	BY	CK	A-E

DRAWN
CHECKED
ENGR
APPROVED BY DATE

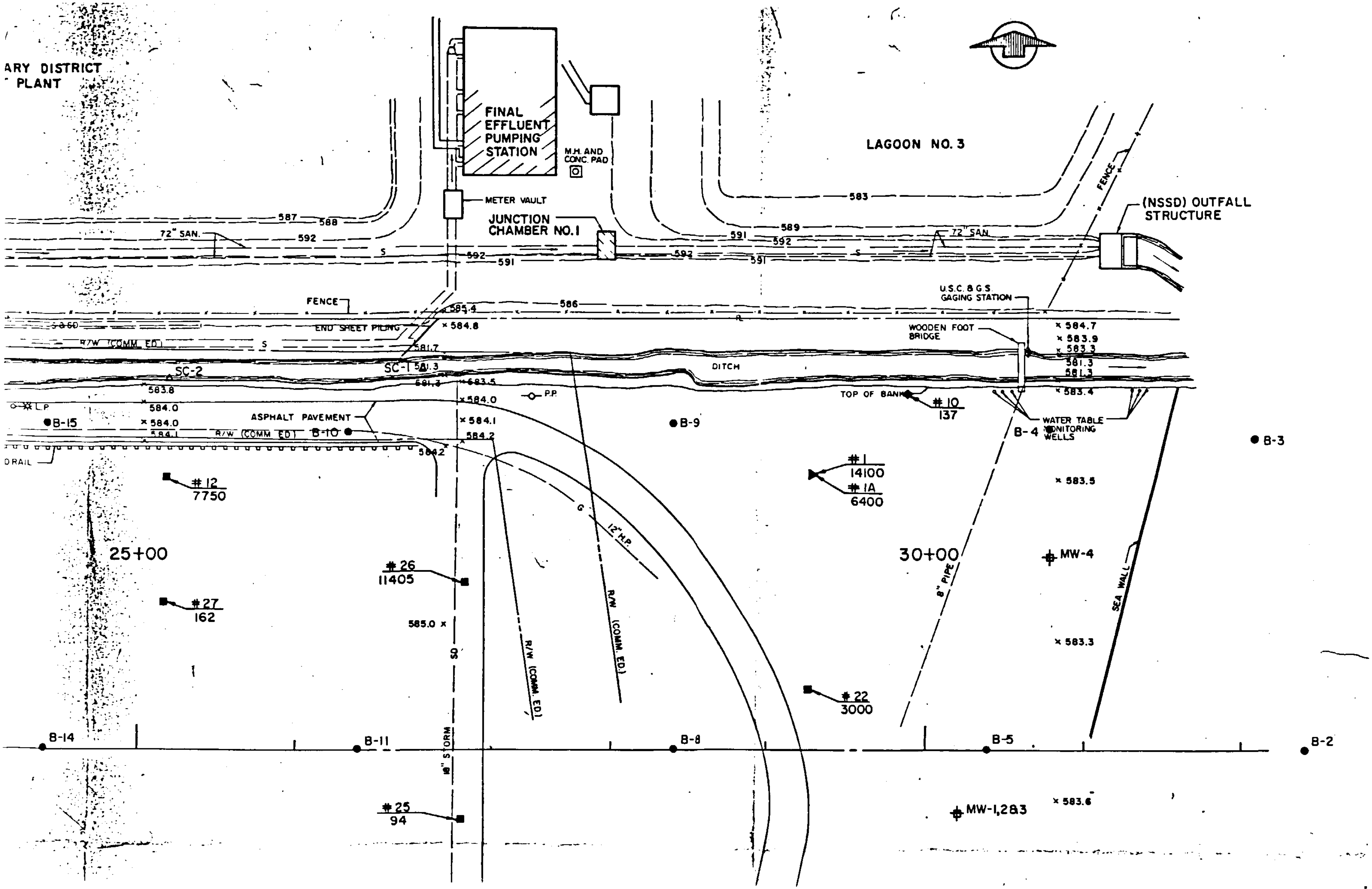
SUBMITTED — DATE
RECOMMENDED — DATE
APPROVED — DATE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

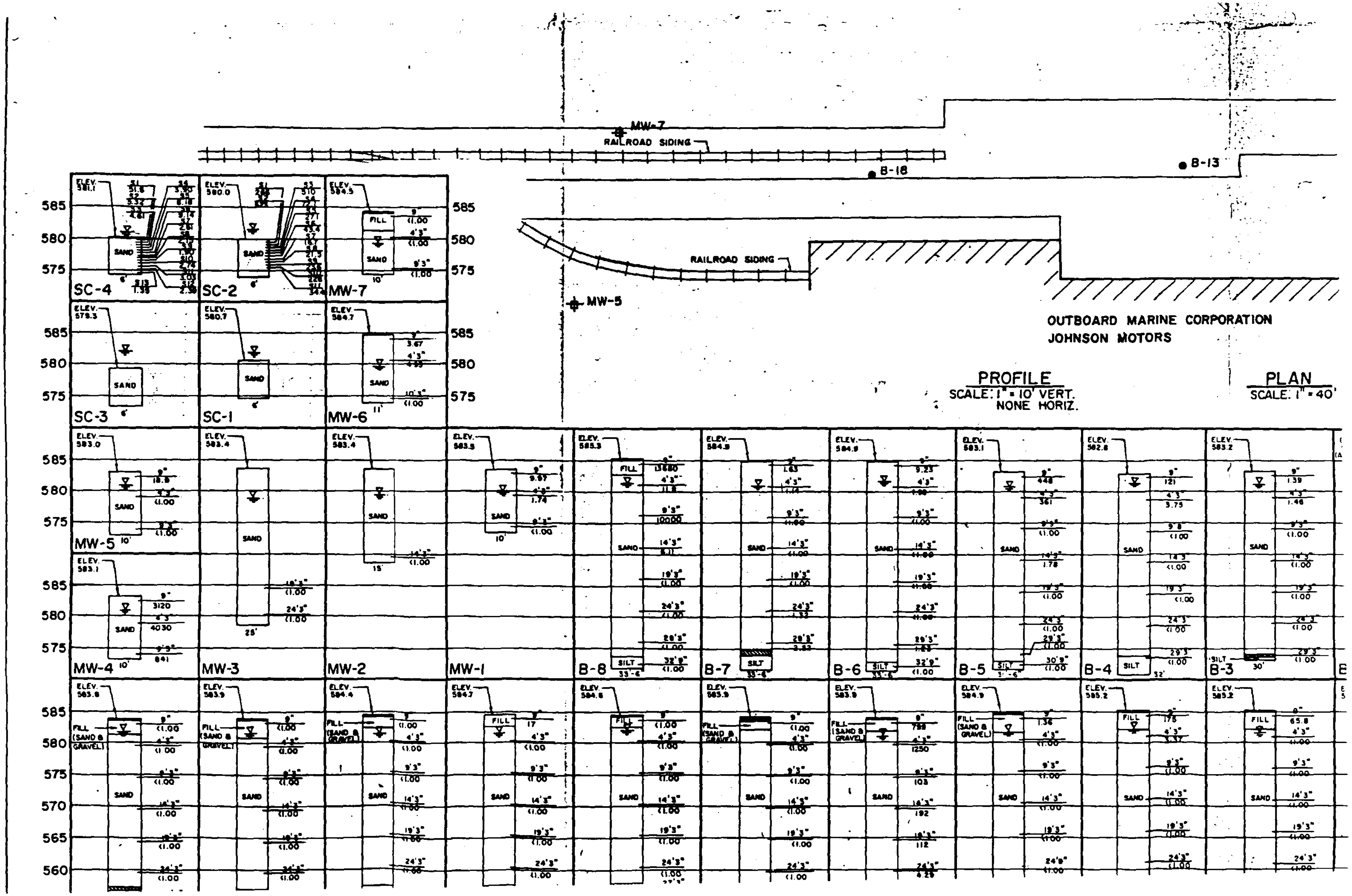
OUTBOARD MARINE CORPORATION — WAUKEGAN, ILLINOI

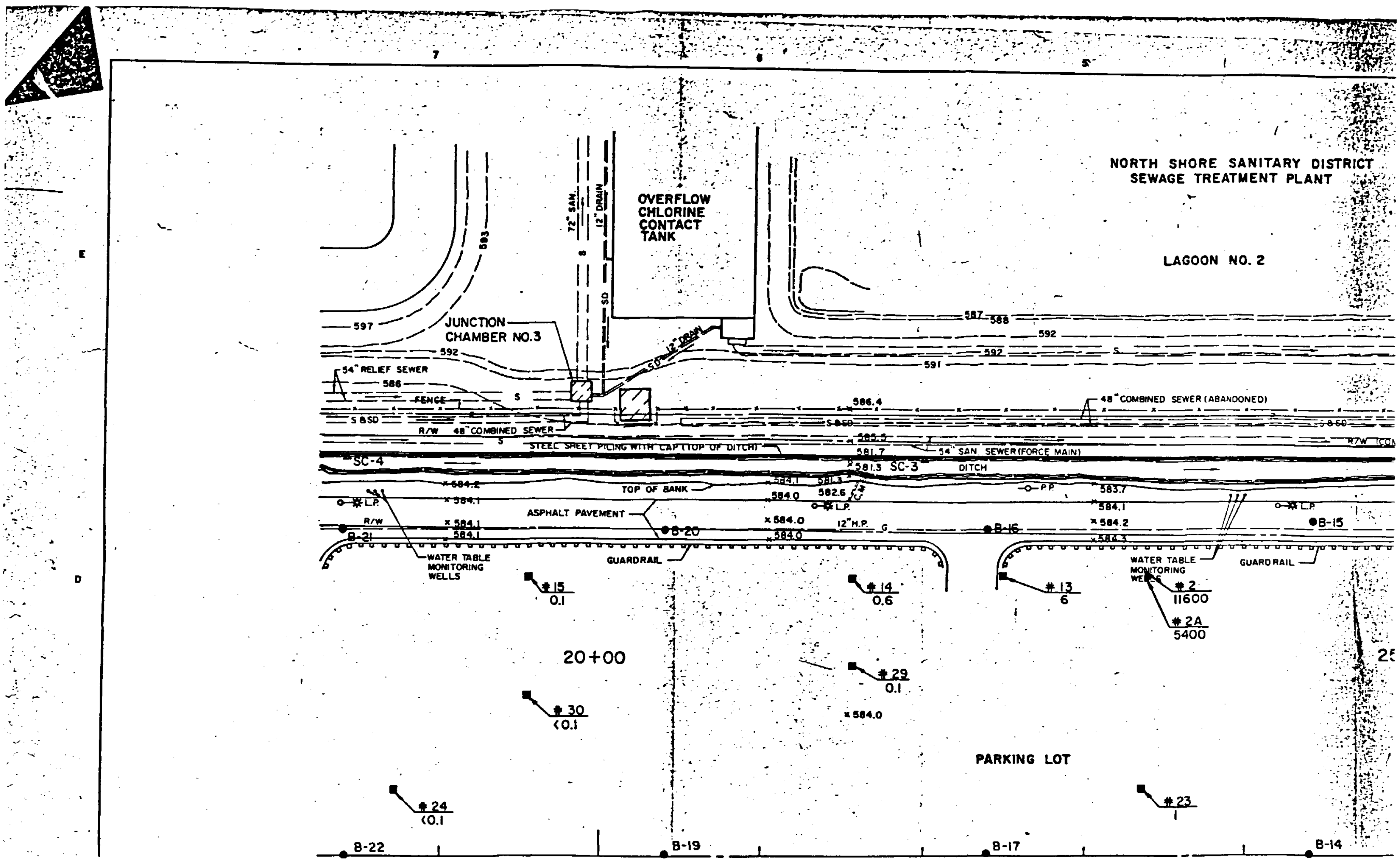
SUBSURFACE INVESTIGATION
NORTH DITCH AREA

CONT. NO.	JOB NO.	SCALE	SHEET NO.	DRAWING NO	REV
		AS SHOWN	2 OF 2		



ARY DISTRICT
PLANT
FINAL EFFLUENT PUMPING STATION
M.H. AND CONC. PAD
METER VAULT
JUNCTION CHAMBER NO. 1
LAGOON NO. 3
(NSSD) OUTFALL STRUCTURE
FENCE
72" SAN.
U.S.C. & G.S. GAGING STATION
END SHEET PILING
R/W (COMM. ED.)
WOODEN FOOT BRIDGE
DITCH
SC-2
SC-1
TOP OF BANK
WATER TABLE MONITORING WELLS
ASPHALT PAVEMENT
P.P.
L.P.
B-15
B-10
B-9
B-4
B-3
#10
137
#1
14100
#1A
6400
#12
7750
#27
162
#26
11405
#22
3000
#25
94
25+00
30+00
12" H.P.
8" PIPE
SEA WALL
MW-4
MW-1,2&3
10" STORM
DRAIL
B-14
B-11
B-8
B-5
B-2


MW-7
RAILROAD SIDING
B-18
B-13
RAILROAD SIDING
MW-5
OUTBOARD MARINE CORPORATION
JOHNSON MOTORS
PROFILE
SCALE: 1" = 10' VERT.
NONE HORIZ.
PLAN
SCALE: 1" = 40'
SC-4
SC-2
MW-7
SC-3
SC-1
MW-6
MW-5
MW-4
MW-3
MW-2
MW-1
B-8
B-7
B-6
B-5
B-4
B-3
585
580
575
570
565
560
ELEV.
SAND
FILL
SILT
FILL (SAND & GRAVEL)



NORTH SHORE SANITARY DISTRICT
SEWAGE TREATMENT PLANT
LAGOON NO. 2
OVERFLOW
CHLORINE
CONTACT
TANK
72" SAN.
12" DRAIN
JUNCTION
CHAMBER NO.3
54" RELIEF SEWER
FENCE
R/W 48" COMBINED SEWER
48" COMBINED SEWER (ABANDONED)
STEEL SHEET PILING WITH CAP (TOP OF DITCH)
54" SAN. SEWER (FORCE MAIN)
DITCH
SC-4
SC-3
TOP OF BANK
ASPHALT PAVEMENT
WATER TABLE
MONITORING
WELLS
GUARDRAIL
L.P.
P.P.
12" H.P.
B-21
B-20
B-16
B-15
#15
0.1
#14
0.6
#13
6
#2
11600
#2A
5400
20+00
#29
0.1
#30
<0.1
PARKING LOT
#24
<0.1
#23
1
B-22
B-19
B-17
B-14

POCKET INSERT 1: FINAL SITE SELECTION AND EVALUATION FOR A HAZARDOUS WASTE DISPOSAL SITE

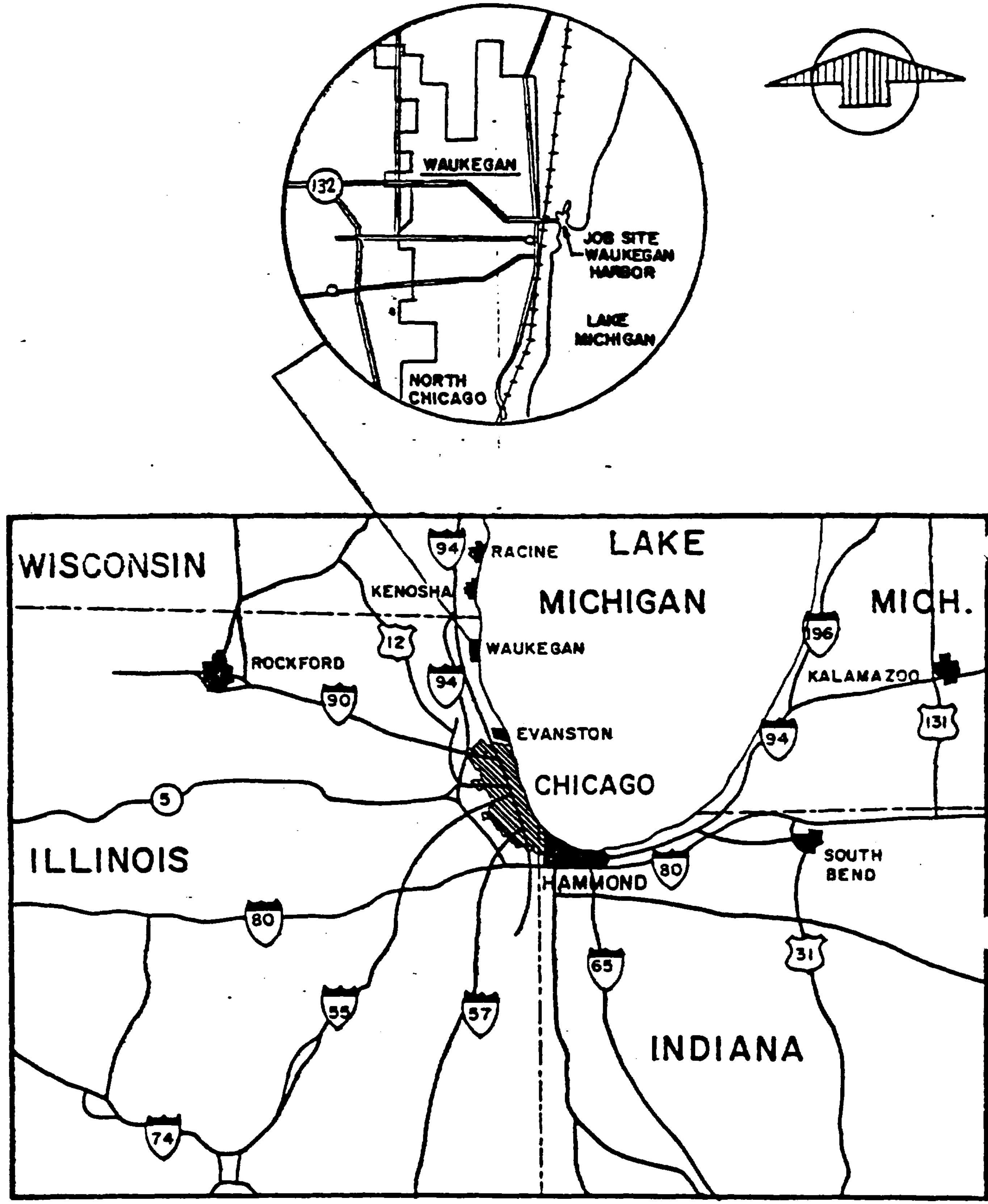


FIGURE I

GENERAL LOCATION MAP

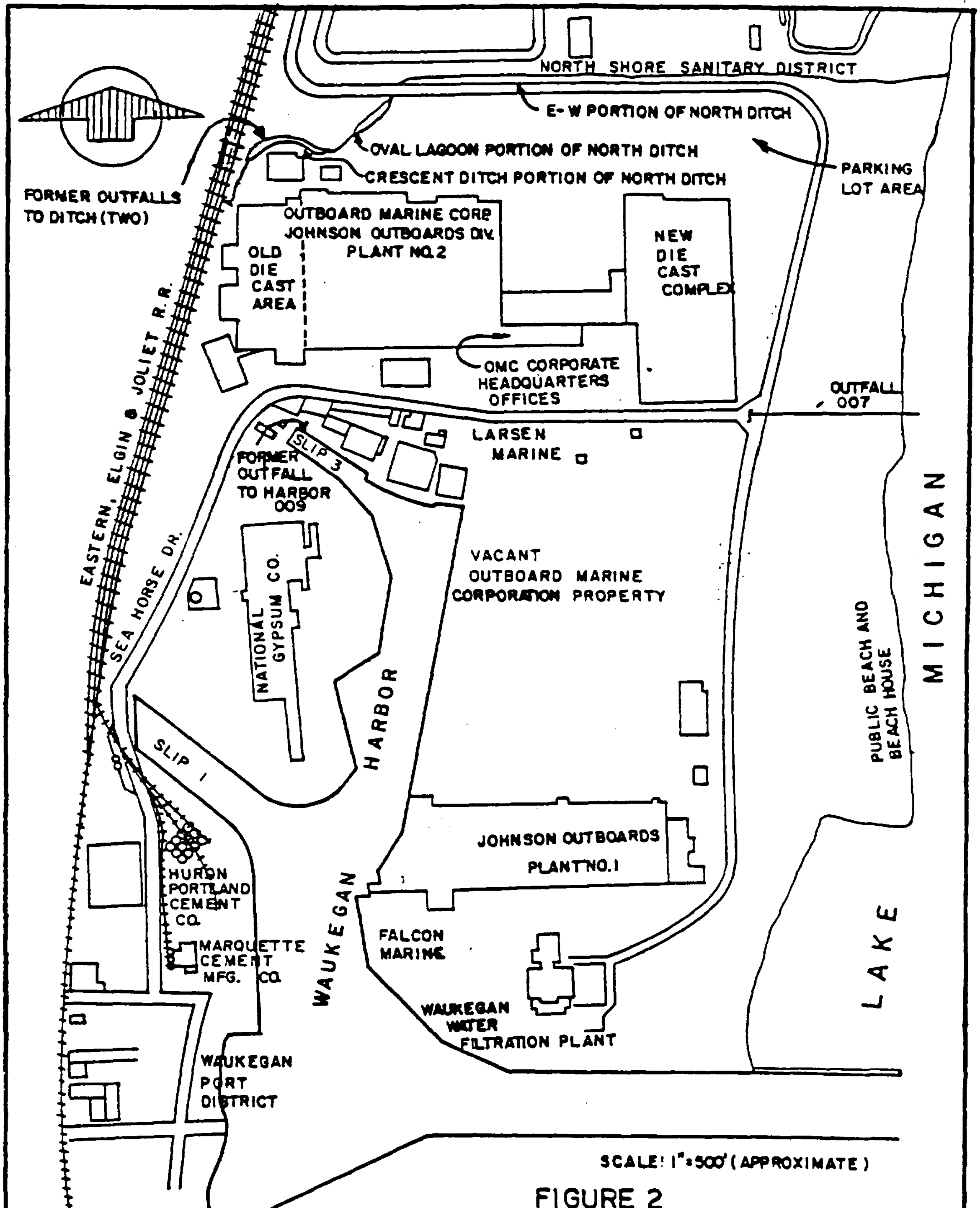


FIGURE 2

LOCATION OF OUTBOARD MARINE CORPORATION PLANT AND PCB OUTFALLS IN RELATION TO SLIP 3 AND THE NORTH DITCH isomer distributions similar to Aroclors 1242 and 1248. These are the designations assigned by Monsanto to certain isomers of PCBs, and the first two digits of the number (in this case 12) indicate the number of carbon atoms in the compound. The second two digits (in this case either 42 or 48) indicate the percent by weight of chlorine in the compound.

The PCBs purchased by OMC for use as hydraulic fluids were a viscous, oil-like liquid heavier than water. They possess several characteristics which make them attractive for use by industry. PCBs are resistant to chemical reactions, have dielectric properties for insulating electrical equipment and are flame retardant. They are known to be soluble in water to a low degree (approximately 100 parts per billion) but are highly soluble in fats and oils (lipophilic). They also become bound to soil particles when brought into contact with them. This is particularly true for smaller (silt-like) organic soil particles.

Because of their resistance to natural mechanisms of degradation, including physical, chemical and biological means, PCBs are very persistent in the environment. In addition, they are highly soluble in organic solvents and will concentrate in the fatty tissues of living organisms. They also biologically magnify as they work their way up the food chain, this being their major threat to mankind. PCBs are solely synthetic and are present in the environment as a result of manufacture by man.

1.3 Purposes for Performing Study

This study evaluates alternatives for the removal, treatment, storage and disposal of the PCB contaminated soils and sediments of Waukegan Harbor and the North Ditch. The alternatives are first evaluated as to practicality and feasibility, with prime considerations the previous and proven experience of the alternative and its compliance status with applicable governmental regulations. The selected alternatives are then evaluated as to cost, ease of implementation and long term effects.

A large scale PCB contaminated material removal project of this type has not been attempted in the U.S. to date. However, the methodologies proposed in this study have been used for other applications. Examples of other restoration projects include (1) the Duwamish River Cleanup for PCBs in Washington State, (2) Hudson River Cleanup for PCBs in New York, (3) James River Cleanup for Kepone, and (4) cleanup of PCBs in harbors in Japan. Several small spill cleanups have been completed by the EPA Environmental Emergency Response Unit in Edison, N.J., and others.

1.4 Scope of Study

The work investigated in this study is included in the following list:

a. Description of the PCB contaminated sites in and near the OMC plant in Waukegan, Illinois.

b. Analysis and compilation of the data presently available concerning the PCB contamination in Waukegan Harbor and the North Ditch and its surrounding areas.

c. Review of applicable governmental regulations.

d. Environmental considerations resulting from either removal or nonremoval of the PCB contaminated sediments and soils.

e. Preliminary evaluation of potentially applicable cleanup techniques resulting in selection of candidate approaches.

f. Detailed engineering and economic evaluation of those candidate approaches resulting from the preliminary evaluation.

g. Discussion and recommendation of ultimate disposal options for the PCB contaminated soils and sediments.

h. Proposed schedules for implementation of the recommended candidate approaches.

i. Cost summary for the candidate approaches.

j. Recommendation of a plan for dealing with the PCB contamination, and the associated implementation schedule and costs.

2.0 EXTENT OF PCB CONTAMINATION AT NORTH DITCH SITE

2.1 General Description of North Ditch

Figure 2 illustrates the general layout of the area. The North Ditch is a small tributary on the west shore of Lake Michigan 37 miles north of Chicago and approximately 10 miles south of the Wisconsin border. North Ditch drains approximately 0.11 square miles of property owned by Outboard Marine Corporation (OMC) and the North Shore Sanitary District at Waukegan, Illinois; about 40 percent of this area has an impervious surface (roads, railroads, buildings, and parking lots). Upstream from Outboard Marine Corporation, North Ditch drains a landfill area (which served as a disposal site for urban debris) composed of sandy material. It then crosses, via a 36 inch culvert the Elgin, Joliet and Eastern Railway Company tracks before entering OMC property. North Ditch enters a 600 foot long by 20 foot wide crescent-shaped channel near OMC buildings referred to in this report as the "Crescent Ditch". The Crescent Ditch formerly received OMC floor drain and storage area discharges containing polychlorinated biphenyls and is still receiving once-through cooling water used in the plant. The Crescent Ditch has a culvert at about 460 feet along its length which conveys North Ditch water under a roadway and railroad siding to an elongated lagoon (referred to as the "Oval Lagoon"). The Oval Lagoon is approximately 240 feet long, 20 to 40 feet wide, and is several feet deep. A culvert at the end of the Oval Lagoon conveys North Ditch water under a roadway to a straight channel about 2,000 feet long, 20 feet wide and several feet deep. The straight channel flows east directly to Lake Michigan. It has a steel retaining wall built by the North Shore Sanitary District on the north side along much of its length. In this report it will be referred to as the "East-West (E-W)" portion of the North Ditch.

North Ditch stream bed material is composed of sand with some gravel. The sand is overladen with organic debris, black-grit, and finer sediments, especially in the Crescent Ditch and Oval Lagoon. Cattails and other vegetation grow along the ditch, and the ditch itself contains considerable algae. Carp and muskrat have been seen on occasion in the ditch.

The depth of water in North Ditch is influenced by Lake Michigan. During periods of on-shore winds, sand piles up at the mouth even to the extent of closing it off. When this happens there is little discharge, and water depth in the ditch begins to rise. Some of the excess water then flows from the ditch into the groundwater table. When lake levels are high with strong on-shore winds, the North Ditch level can reach the top of its banks. Then the excess sand at the North Ditch mouth must be removed to prevent flooding of the area. During periods of off-shore winds, the North Ditch mouth tends to open up, the water level in North Ditch drops, and there is a net flow of ground water into the Ditch. The flow in North Ditch's E-W portion of the channel can therefore be in either direction depending upon changes in lake level in response to shifts in wind direction. Ground water can flow likewise into North Ditch or North Ditch water can seep into the Lake via the ground water. Portions of OMC property consist of sandy-fill material. According to the U.S. EPA, the fill was in part obtained from dredging the North Ditch channel.

The Environmental Control Technology Corporation, Ann Arbor, Michigan (ENCOTEC), consultants to OMC, have estimated a dry weather base flow of about 100,000 gpd in North Ditch. During very dry weather, the flow may not enter the Lake but may percolate through the bottom into ground water. OMC discharges roughly 150,000 gpd of once-through cooling water into the Crescent Ditch. Portions of this water originate from Slip #3 of Waukegan Harbor. U. S. Department of Interior measurements near the mouth performed during the period March 13 through September 30, 1979 showed an average discharge of 350,000 gpd with variations from 65,000 gpd to 1,200,000 gpd and a peak instantaneous discharge of up to 5.3 cubic feet per second (equivalent to 3,500,000 gpd). The 5 year storm event of 3 hour duration is calculated to result in a discharge of up to 75 cubic feet per second.

2.2 Contamination in North Ditch

2.2.1 Background Information Concerning Discharges

Since the early 1950's until the mid 1970's, Outboard Marine Corporation used hydraulic fluids containing PCBs in their aluminum die cast machines. Outboard Marine Corporation is believed to have purchased approximately 9 million pounds of PCB between 1959 and 1971 (an Aroclor product), and a phosphate ester product containing PCBs from 1951 through 1959. Since 1971, OMC began replacing PCB hydraulic fluids with non-PCB fluids as the machines required.

Becuase the hydraulic systems in which the hydraulic fluids were used routinely leaked, the PCB bearing fluids escaped from the die cast machinery onto the surrounding floor area. Outboard Marine Corporation has advised the U.S. EPA that possibly 10 or 15 percent of all PCBs purchased may have escaped via floor drains which lead to North Ditch and Waukegan Harbor. EPA has estimated that the discharge could have been as high as 20%. OMC is reported to be able to account for all but perhaps 1,500,000 or 2,000,000 pounds. The contamination was brought to the attention of EPA by Illinois in 1976. At that time, the EPA estimated that OMC was still discharging on the order of 10 pounds per day of PCB to North Ditch and Waukegan Harbor combined.

The PCBs entered North Ditch via floor drains which connected to two outfalls entering the Crescent Ditch portion of North Ditch. These outfalls were ordered sealed by OMC when administrative orders were issued by U.S. EPA and Illinois in February 1976 A third outfall, at the east end of the Crescent Ditch, currently discharges approximately 150,000 gpd of non-contact once-through cooling water. This cooling water supply partially originates from Slip #3 in Waukegan Harbor.

2.2.2 Review of Previous Studies

2.2.2.1 Preliminary U.S. EPA Grab Samples

Preliminary grab samples collected June 9, 1976 by the U.S. EPA of the uppermost North Ditch sediments confirmed heavy PCB contamination. The results of these surface sediment grabs were as follows:

Location	Concentration of PCB (ppm)
North Ditch At Railroad (before OMC outfalls)	87
Crescent Ditch at OMC outfall	246,000
Inlet to Oval Lagoon	34,900
North Ditch (E-W Portion - west end)	300
North Ditch (E-W Portion - east end)	620
North Ditch (E-W Portion - near Lake)	1.6

Concentrations of PCB are reported on a dry weight basis in parts per million (ppm), which is equivalent to milligrams per kilogram of sample.

2.2.2.2 Illinois EPA Core Samples

The Illinois EPA collected sediment core samples to a depth of 7 feet on February 16-18, 1977 and on June 9, 1977 at (1) edge of Crescent Ditch near OMC outfall, (2) center of Oval Lagoon, (3) North Ditch (E-W portion; 1300' from Lake) and (4) North Ditch (E-W portion, 400' from Lake). The Crescent Ditch sample showed very high concentrations of PCBs:

Depth Into Sediment	PCB Concentration, ppm
Surface grab (June 1977)	32,000
3 feet (February 1977)	376,000
5 feet (February 1977)	38,000
7 feet (February 1977)	24,000

The PCB concentrations dropped off rapidly as North Ditch approached Lake Michigan. For example, a sample taken in the East-West (E-W) straight portion 400 feet from the Lake showed the following:

Depth Into Sediment	PCB Concentration
Surface Portion (February 1977)	33.41
1 foot	27.08
2 foot	9.91
3 foot	6.56
4 foot	122.00

2.2.2.3 Environmental Control Technology Corporation (ENCOTEC)

ENCOTEC, Ann Arbor, Michigan, under contract for OMC collected in April 1977 sediment core samples in North Ditch starting from the point where North Ditch crosses the railroad entering OMC property. The following information was provided to U.S. EPA on PCB concentrations (ppm or mg/kg):

Depth	D1	D2	D3	D4	D5	D6
1 ft.	220	8,300	8700-115,000	62	2,600	6.5
2 ft.	1.9	69,000	15-145,000	6,000	54	8.4
3 ft	0.38	21,000	7,100-7,300	29	4.5	90
4 ft	0.19	12,000	5,100-3,800	6.6	7.7	9.9
5 ft.	0.18	3,700	130-67	6.1	4.1	1.8
6 ft.	0.23	19,000	14-0.33	1.8	5.0	2.3
7 ft.	0.99	44,000	24-0.37	2.6	2.2	2.5

Location

D1: North Ditch crossing railroad entering Crescent Ditch
D2: Crescent Ditch near OMC outfall.
D3: Believed to be multiple samples taken at entrance to or within Oval Lagoon.
D4: North Ditch, E-W straight portion, about 1600 feet from Lake.
D5: North Ditch, E-W straight portion, about 500 feet from Lake
D6: North Ditch about 100 feet from Lake.

2.2.2.4 Battelle, Pacific Northwest Laboratories

Battelle, Pacific Northwest Laboratories, under contract with the U.S. EPA, evaluated alternatives for removal/destruction of PCB-contaminated sediments in the North Ditch. Battelle recommended (1) removal of North Ditch contaminated sediments using the Mud Cat dredge, (2) comingling with Waukegan Harbor sediments also to be removed with a dredge, and (3) codisposal with Harbor sediments in the Browning-Ferris Industries landfill near Zion, Illinois.

Battelle, having available at the time of the study only the preliminary EPA grab samples, Illinois EPA core samples, and ENCOTEC results, estimated the quantity of contaminated sediments as 3,800 cubic yards (greater than 100 ppm) or 6,300 cubic yards (greater than 10 ppm). They did not look for any contamination deeper than 7 feet or outside the North Ditch channel itself.

2.2.2.5 Soil Testing Services, Inc. Results

The Soil Testing Services, Inc. of North Brook, Ill., under contract for OMC obtained in September 1976 deep cores of North Ditch bottom sediments. Soil Testing Services used a thick-walled piston sampler to obtain samples down to a depth of about 30 feet. The method was such that the softer, PCB-contaminated top sediments were bypassed and the deeper sand was obtained. OMC or its agent later contracted with ENCOTEC to sample the top sediments. The results are in the appendix. The highest PCB concentration in any sample analyzed was 17,000 ppm; this sample was located at a depth of 7 to 7.5 feet (water depth 0.6 feet) near the west end of Crescent Ditch roughly 100 feet upstream from the OMC outfall. At 10.5 to 11 feet, the PCB concentration was 190 ppm, but at 4 to 4.5 feet, the PCB concentration was only 0.1 ppm. The data are signficant in that there is (1) some low level contamination at many locations, even as deep as 23 feet (2.8 ppm of PCB), and that (2) there may be pockets of higher contamination or no contamination in the deep soils. Unfortunately, a deep core boring apparently was not made at the OMC outfall.

2.2.2.6 U. S. EPA Sampling (January 1980)

In 1979, the U.S. EPA was examining plans for bypassing the North Ditch as an alternative to prevent washing contaminated North Ditch sediments into Lake Michigan. The bypass was to run through OMC's parking lot south of the E-W straight portion of North Ditch. However, groundwater observation wells at the east end of the OMC property yielded ground water with higher PCB concentrations than what would be expected if soluble PCBs had simply diffused or were carried from North Ditch. Therefore, the U.S. EPA directed core borings to be taken in January 1980 at scattered locations on the south side of North Ditch on OMC property. The borings were obtained on dry land to a depth of 5 feet. The analysis results, presented in the pocket insert of the appendix of this report, showed areas of contaminated PCB soils under the east end and beyond the east end of the OMC parking lot, with concentrations up to 14,000 ppm of PCB. Consequently, the North Ditch bypass plan through the parking lot was put in abeyance pending further investigation.

Based upon documents provided during discovery in the pending lawsuit against OMC and Monsanto, OMC is believed to have dredged North Ditch (perhaps even changing the channel) years ago and used dredge spoils as fill for their parking lot and grounds.

2.2.2.7 JRB Associates, Inc.: Study of Groundwater

JRB Associates, Inc., McLean Virginia, under EPA contract, investigated the extent of groundwater contamination at and near Outboard Marine Corporation. Warzyn Engineering Inc., Madison, Wisconsin, was subcontracted to collect soil borings. The EPA sampling and observation well (described in section 2.2.2.6) results were available for the JRB study. Ground water samples taken from observation wells at the east end of the parking lot averaged about 50 ppb PCB (some samples over 100 ppb PCB) reflecting PCB contamination, probably due to buried material in this parking lot.

Of interest to this study is soil sample 7C collected in the Crescent Ditch about 200 feet east of the closest OMC outfall where PCBs were discharged:

Depth	PCB Concentration (ppm)
0 to 1.5 feet	12,000
2.5 to 5 feet	1,300
5.0 to 7.5 feet	12,000
8.5 to 10.0 feet	120
13.5 to 15 feet	3.5
18.5 to 20 feet	97
23.5 to 25 feet	15

The results showed some contamination even down to 25 feet depth. At the 20 foot depth, the soil composition changes from sand to silty clay; as a result, there appears to be a slight tendency for PCB to pool at 18.5 to 20 feet.

2.2.2.8 Environmental Emergency Response Unit - Subsurface Borings

The U.S. EPA, through the Environmental Emergency Response Unit at Edison, N.J., contracted with Mason & Hanger-Silas Mason Co., Inc. (Mason & Hanger) to obtain core borings throughout Outboard Marine Corporation property in order to define PCB contamination. Warzyn Engineering, Inc. of Madison, Wisconsin performed the core borings; all samples collected were delivered to Raltech Scientific Services, Madison, Wisconsin, for analysis. Chain of Custody procedures were followed for this work as with previous U.S. EPA and Illinois EPA studies. The subsurface investigation, performed in late May and early June 1980, consisted of (1) 39 soil borings ranging in depth from 25 to 35 feet, (2) five soil borings to a depth of 6 feet, (3) installation of seven groundwater monitoring wells, and (4) 20 six foot long sediment cores from North Ditch. The deep core borings were sectioned into segments with samples taken at 9 inches, 4 feet 3 inches, 9 feet 3 inches, 14 feet 3 inches, 19 feet 3 inches, 24 feet 3 inches, and possibly selected other depths set aside for PCB analysis. The sediment core samples were sectioned into 6 inch segments and analyzed. Location of all these borings are shown in the appendix.

Warzyn Engineering, Inc., reported that the samples consisted primarily of sand down to depths ranging generally from 23 to 30 feet. Fill material (usually 2 to 6 feet deep) exists at some locations. The North Ditch sediment core samples contained a few feet of black loose muck on top of the sand at many locations. Underneath the sand (23 to 30 feet) was gray silt (described by Warzyn as "gray silt, some to little clay, little to trace sand, trace gravel").

At the writing of this report, Raltech had completed PCB and percent moisture analyses for all except for boring numbers SC1, SC5, SC11B, SC3, B10 and B23 placed in their custody. Raltech reported PCBs as Aroclor 1242 or 1248. These PCB analysis results are presented in the appendix on the pocket insert map. Percent moisture for the sand samples ranged typically from 75 to 92 percent, with most samples between 80 and 85 percent.

Core boring B32 located at the edge of the Crescent Ditch about 20 feet from the OMC outfall 013 (one of the two discharges containing PCBs before it was sealed off) deserves special discussion:

Depth	Soil Type	PCB Concentration	Percent Solids
9"	fill material (sand)	55,000 ppm	88.1%
4'3"	sand	11,630	84.2%
9'3"	sand	56,100	82.1%
14'3"	sand	738	82.5%
19'2.5"	sand	6.25	81.9%
19'10.4"	gravel	137,100	81.1%
23'9"	wood	17,600	39.8%
24'3"	gray silt	5,730	92.4%
24'9"	gray silt	240	91.2%

The core boring shows that PCB liquid has pooled near or at the plant outfall, penetrating through the sand to the underlying gray siltly clay. The PCB liquid has pooled on top of the underlying gray silty clay which starts at a depth of 20 feet; a concentration of 137,100 ppm PCB (Aroclor 1242; dry basis) was found on top of this gray silty clay. A wood-like peat finger happens to exist at this particular location which extends deeper into the silt, and PCBs have penetrated at least another 4.5 feet via this finger.

The PCB penetration into the sand is not uniform. There are zones of low contamination (e.g. 6.25 ppm PCB at 19'2.5") adjacent to zones of high concentration (e.g. 137,100 ppm at 19'10.4"). The behavior is like a heavy immiscible liquid dropping pockets of high concentration as it sinks, bypassing other areas leaving them essentially uncontaminated. The water table was 34 inches below the surface at location B32 on the date of sampling.

Core boring B8 at the east end of the OMC parking lot also illustrates the non-uniformity of PCB concentrations with respect to depth..

Depth	Soil Type	PCB Concentration	Percent Solids
9"	fill (sand)	13,680 ppm*	91.6%
4'3"	sand	11.8	82.7%
9'3"	sand	10,200	82.4%
14'3"	sand	6.11	80.7%
19'3"	sand	less than 1 ppm	82.1%
24'3"	sand	less than 1 ppm	81.2%
29'3"	sand	less than 1 ppm	81.2%
32'9"	gray silt	less than 1 ppm	89.0%

*Aroclor 1242, dry basis.

A low concentration of 11.8 ppm PCB at four feet is sandwiched between zones of concentrations over 10,000 ppm near the surface and at nine feet. This sort of behavior makes any estimate on total quantity of PCBs still left at the North DItch site very difficult.

2.2.3 Conclusions Learned From Previous Studies

1. The North Ditch area is contaminated with PCBs, with concentrations highest (some over 100,000 ppm) near the OMC outfalls.

2. PCBs have pooled near the two OMC outfalls in the Crescent Ditch, and have sunk through the sand pooling near the top of the underlying gray silt "clay" layer at a depth of 20 feet. Some penetrations even into this underlying layer has occurred with a concentration of 240 ppm PCB found at a depth of 24'9".

3. PCB contamination also exists under the OMC parking lot, with concentrations of 10,000 ppm PCB at a depth of 9 feet at one location. The parking lot contamination is believed to originate at least in part from North Ditch material used as parking lot fill.

4. The PCB concentrations often do not uniformly change with respect to depth or location. Relatively high concentrations of PCB can be found near places of low concentration. This makes any estimation of extent of contamination difficult.

2.2.4 Estimation of PCB Contamination

Few natural or man-made boundaries exist in the North Ditch area to define PCB contamination. Any estimate of the extent of contamination can only be made to an order of magnitude based on the information available.

Figures 3, 4, 5 and 6 illustrate the locations of areas known to have soils contaminated to the extent of 20 ppm PCB, 50 ppm PCB, 500 ppm PCB, and 5,000 ppm PCB. Locations over 50,000 ppm PCB are confined to part of the Crescent Ditch and pockets in the Oval Lagoon.

The U.S. EPA has suggested 50 ppm PCB as the regulatory cut-off point (Federal Register May 31, 1979) under the Toxic Substance Control Act (TSCA) for disposal of contaminated solids in a hazardous waste landfill. While materials containing less than 50 ppm PCB are not negotiated under TSCA with respect to disposal in hazardous waste landfill, the preamble to those regulations explicitly recognize and preserve the authority of the Administrator to regulate PCBs at levels less than 50 ppm under other statutes. This cutoff point of 50 ppm PCB was recently challenged (EDF vs. EPA, U.S. Court of Appeals, Washington D.C., 79-1580, 79-1811, 79-1816), and EPA was asked to revise some applications of the 50 ppm limit as a result of the court decision on October 30, 1980 or provide further documentation of why 50 ppm is acceptable. For the purpose of this report, Mason & Hanger is using 50 ppm as the cutoff point for estimating cubic yardage of contaminated soils for considering alternative disposal plans. Based on available core corings, a 20 ppm limit should not significantly increase yardage.

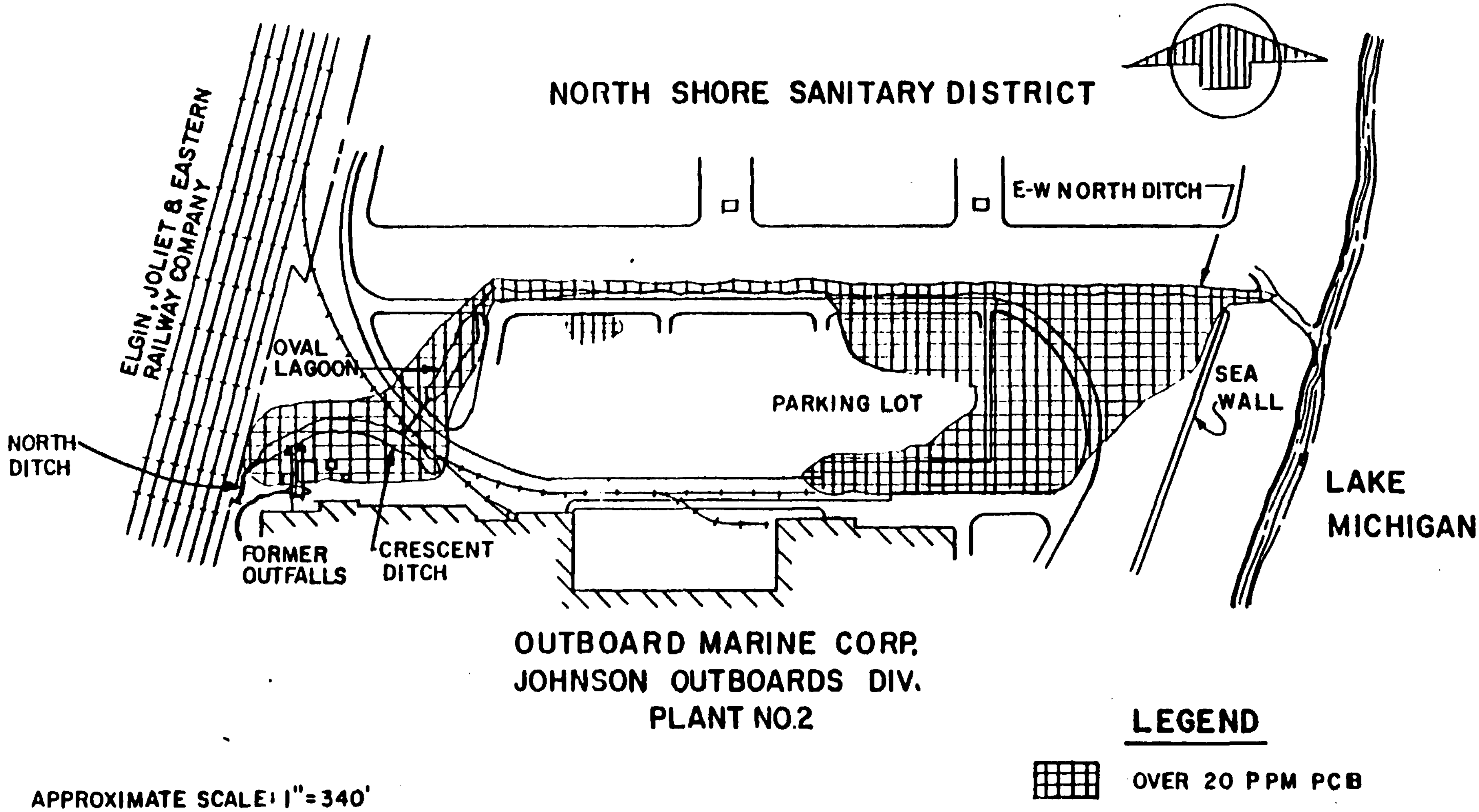


FIGURE 3
NORTH DITCH AREA
EXTENT OF PCB CONTAMINATION
OVER 20 PPM